INTERNATIONAL

MARINE ENGINEERING

Published Monthly by ALDRICH PUBLISHING CO.

461 EIGHTH AVENUE, NEW YORK

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Associate Inst. N. A.

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Member Soc. N. A. and M. E.

Vol. XXI SEPTEMBER, 1916 No. 9

Progress of American Shipbuilding

STEEL merchant vessels building or under contract to be built in private American shipyards on August 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 389 of 1,260,978 gross tons, an increase of four vessels and 35,194 tons over the returns for July 1. Barring delays, the builders expect to launch during the current fiscal year 340 vessels of 1,004,523 gross tons.

Effect of War on Shipbuilding

STATISTICS showing the number and tonnage of steam vessels owned by the various nations of the world, contained in the new issue of Lloyd's Register, indicate that war losses and the curtailment of new production have caused a slight reduction in the total since the beginning of hostilities. The number of vessels listed under date of June, 1914, was 24,444, with an aggregate gross tonnage of 45,403,877, as compared with 24,132 vessels with an aggregate gross tonnage of 45,247,724 on June 30, 1916. Lloyd's figures show that the United States has made the greatest gain reported by any nation. This increase has been confined entirely to ocean-going vessels, which have increased in number from 172 and in tonnage by 825,627. To offset this increase, there has been a slight decline in the number and tonnage of American lake vessels, some of which have been withdrawn for ocean service. Taking these losses into consideration, the gain of the American merchant marine has been 147 steamships of 786,137 gross tons.

Who Will Build the Ships?

THE naval programme authorized by Congress calling for the construction of no less than 157 vessels of approximately 855,000 tons displacement, 66 of which of about 382,000 tons are to be begun as soon as practicable, and the remainder before July 1, 1919, fittingly expresses the will and desire of the majority of the citizens of the United States for the liberal and adequate development of the nation's first line of defense. It should be remembered, however, that the expeditious and successful fulfilment of this programme rests largely upon the shipbuilding facilities made available and maintained by private enterprise. The strength of a nation at sea rests not alone in its ships, but also in its facilities for building and repairing ships.

The Forerunner of the Deutschland

REMARKABLE as the exploits of the merchant submarine *Deutschland* have seemed to the general public, nevertheless those who have followed the experimental work and development of submarine vessels for the past quarter of a century will recall that as long ago as 1897 Chesapeake Bay was the scene of far more significant, if less spectacular, submarine exploits. In that year the first submarine boat to be equipped with an internal combustion engine was built and successfully operated in Chesapeake Bay. This was the *Argonaut,* a vessel 36 feet long and 9 feet in diameter, propelled by a 30-horsepower gasoline (petrol) engine. She was designed and built by Mr. Simon Lake and in January of the following year Mr. Lake navigated the *Argonaut* in stormy weather, under her own power without escort, from Baltimore to New York. It was from the work of Mr. Lake and in accordance with his designs that Germany began her development of the submarine which has culminated in the construction and successful operation of the *Deutschland.*

Navy Department Adopts Geared Turbines for Destroyers

IT has recently been announced that the Navy Department intends to re-engine several naval vessels now in service, which, when they were constructed, were equipped with direct connected turbines. The first two to be so reconstructed will be the destroyers *Henley* and *Mayrant.* These are to be equipped with geared turbine units for which contracts have been placed with the Westinghouse Machine Company, East Pittsburgh, Pa.

Geared turbines have been adopted, due to the fact that they are lighter and take up less space than direct connected units, and also due to the fact that the steam consumption is materially reduced at all speeds and especially at cruising speeds. This decrease in steam consumption means not only a reduction in fuel consumption but also an increase in the steaming radius, which is an important feature in this type of vessel.

The *Henley* was built by the Fore River Shipbuilding Company, Quincy, Mass., and completed in the fall of 1912. The main machinery consisted of two direct connected turbines with two compound reciprocating cruising engines which were connected to the main turbine shafts by means of jaw clutches. The machinery to be supplied by the Westinghouse Machine Company will consist of two geared turbine units of the impulse reaction type, with Kingsbury thrust bearings and two geared cruising units. The new machinery will be installed in the same engine room space and will be connected with the existing propeller shafting and drive the propellers at the same speed as formerly. The two cruising turbines will each have a capacity sufficient to drive the ship at a speed of 15 knots. They will be connected to the main turbines by clutches and will be used only up to a speed of 15 knots. After this speed has been attained, they will be disconnected and the main turbines alone used. The turbine speed of 3,000 revolutions per minute will be reduced by the reduction

gears down to 640 revolutions per minute for the propeller shafting.

The *Mayrant* was built by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and delivered to the government in 1911. The propelling machinery consisted of two direct connected turbines without cruising engines. The turbines were designed to develop 13,000 shaft horsepower at a speed of 650 revolutions per minute with a steam pressure of 250 pounds gage. The new machinery for this vessel will be essentially the same as that for the *Henley*. The main turbines, however, will each have a capacity of 7,000 shaft horsepower at a speed of the propeller shafting of 629 revolutions per minute. The speed of the turbines will be 3,000 revolutions per minute.

Fuel Values of Alaska Coal for Marine Service

BY L. R. W. ALLISON

An important series of tests of Alaska coal, mined at Matanuska, has recently been made by the United States Navy Department, aboard the cruiser *Maryland*. Advance data giving the results of these tests are particularly interesting in showing the efficient fuel value of coal from this section, which with its vast deposits is destined to be a primary source of future supply for high grade anthracite coal.

The navy tests were conducted under four different conditions of operation, as follows: (1) port test, seven days' duration; (2) four-hour, forced draft, 20-knot test; (3) twenty-four hour, 15-knot test, and (4) 10-knot test;

The accompanying summary of the results of these tests is based upon a comparison with coal from the Pocahontas fields of West Virginia, a source of supply which is extensively used for Government service. This coal rates:

	Percent
Volatile matter	17.0
Fixed carbon	76.5
Ash	6.5
	100.0

Sulphur, 0.65 percent.
Moisture (coal as received), 2.5 percent.
Heat value, 14,700 B. T. U. (8,170 calories).

The heat value of coal from this field is found to vary from 15,000 B. T. U. (8,335 calories) to 14,500 B. T. U. (8,060 calories), with an ash content from 4.5 to 8 percent, respectively.

With coal from the Alaska field it is found that slight foreign matter exists, with no evidence of gas being given off during the tests. The coal is particularly friable, the lumps readily crumbling and pulverizing, while the slack has a tendency to burn better than the lump. A digest of the different tests follows:

Port Test—Seven days:

One boiler in service; all coal, ash and clinker were weighed. Run of mine coal employed for five days, slack one day and lump coal one day; forced draft necessary on two days.

Coal burned freely; firing was very good, analysis of flue gases showed rarely below 9 percent CO_2. Fire 6 to 8 inches thick carried during most of the period, occasionally slightly heavier. Draft was good, coal burning with bright yellow flame.

There was little clinker, but ash several percent higher than with Pocahontas coal; ash fused into clinker on the grate bars, generally about 2 inches thick, medium weight and porous, slightly touch and hard while hot, friable when cold. Clinker carried a little ash mixed throughout the mass, and adhered a little to the bridge wall, but not seriously.

Coal coked nicely, coke being friable and easily worked. Soot deposit about 25 percent greater than Pocahontas coal and slightly different, the granules appearing as minute fused grains. The load carried during the period of test would have ordinarily required two boilers using Pocahontas coal.

Four-Hour.—Forced draft, 20-knot:

Fires thin and burned brightly; firing easy, due to ready breaking up of coke. Dampers partly closed; furnaces formed one mass of yellowish flame. No excessive mass of ash formed.

Twenty-Four Hour.—Fifteen-knot:

Inaugurated with a battery of twelve boilers, but four later cut out to gain the highest efficiency. Fires carried from 6 to 8 inches thick; always glowing, ashpans bright; furnaces formed one mass of yellowish flame. Coal burned with great care, formed an easily worked coke, no excessive amount of ash or clinker.

Clinker friable when cold. Fires noticeably hot; coal burned like pine knots; in general, seemed easier to handle than Pocahontas coal. Analysis of flue gases showed generally high CO_2, over 9 percent. Total soot deposit about 10 percent more than generally made by Pocahontas coal.

Ten-Knot.—Inaugurated with a battery of six boilers, but two later cut out to give the greatest efficiency. Power afforded more than necessary, at times four evaporators being in use. Fires easily worked; coke easily broken; fires carried from 6 to 8 inches thick, occasionally slightly heavier, bright and level; clinker not very hard. Analysis of flue gases showed generally high CO_2.

The Economics of a Steamship Line

BY E. N. PERCY

This article, one of a series dealing with analytical methods applied to marine enginering, will take up the subject of economics under the following headings:

- Investment
  - Hulls
  - Machinery
  - Gear
  - Shore Plant
  - Interest
- Depreciation
  - Hulls
  - Boilers
  - Machinery
  - Gear
  - Repairs
- Hazard
  - Loss and Damage
  - Insurance
  - Responsibility
  - Safety Devices
- Earning Capacity
  - General Shipping
    - Freight
      - Cost
      - Classification
      - Rates
    - Passengers
      - Cost
      - Classification
      - Service
      - Rates
  - Specific Shipping
    - Colliers
    - Tankers
    - Ore Carriers
    - Grain Carriers
    - Lumber Carriers
    - Refrigerator
    - High Speed Pass.
- Obtaining Business
  - Estimating
  - Chartering
  - Salesmanship
  - Advertising
  - Service

Any given line of steamships will consist, as a rule, of a variety of designs, of different ages and different stages of depreciation. To arrive at the investment in a given ship, as a unit of an operating line, the following factors must be considered:

Original outlay for hull.

Original outlay for machinery, gear and furnishings.

Subsequent outlay for new machinery, etc.

Proportionate part of investment in shore plant for maintenance.

Balanced against these must be:
Depreciation charged off.
Salvage of machinery and gear removed.
Proportionate part of salvage from shore plant.

Often a new hull will have old machinery or an old hull new machinery. The same applies to gear, etc. Sometimes a steel ship will have extra wooden cabins added, which depreciate more rapidly than the rest of the ship but greatly increase the earning capacity. All such changes should be carried on special accounts, so that the value of that part of the investment may be arrived at. It is an unfortunate fact that ships can be built abroad much more cheaply than in America with proportionately less investment. Our laws are such that ships for interdomestic ports are necessarily constructed at home; but the economic laws of trade are such that our export trade will always be carried in foreign bottoms, financed in many cases in America, for American trade. It is not possible to combat these natural trade laws, except by creating artificial conditions that are necessarily short lived. Capital will not venture into American bottoms as an investment so long as foreign countries can build and operate ships more cheaply than we can, except in those cases where the ships are built to serve a particular industry. These conditions must be recognized as a basis of all marine investment. We can create and maintain artificial conditions at home by tariff, subsidies, etc., which are merely means of distributing over the population at large burdens which are normally carried by the shipper. So long as the people enjoy a compensating industrial activity this can be done, but the history of subsidies has been a gradual relapse to the normal condition, since natural laws will balance. For instance, the building up of the German and English merchant marines was a secondary result of the fact that these countries could produce their goods and build their steamships more cheaply than the rest of the world. These matters are mentioned merely because they affect investment, and are, in fact, vital to investment.

The fact that various parts of a ship depreciate at different rates is sufficient indication that they should be carried on separate accounts and be charged off at different rates, as any part of a ship may be renewed, or may even be transferred to another hull. All repairs and maintenance are charged off to depreciation. The operation account should be charged with material consumed only, since any repairs or maintenance are due to depreciation even if caused by operation. In the event that repairs eventually exceed the original cost of the part repaired, they should then be credited to investment. When this investment rises to a point that the ship is not paying proper dividends on the money invested, the ship must be scrapped or rebuilt. A ship, like any other structural property, is governed by the law of diminishing returns. These returns can be increased from time to time by repairs, rebuilding, etc., but there finally comes a time when the returns are so diminished and the cost of further repairs so high that it is cheaper to scrap the ship and realize such salvage as is possible from the hull and machinery and gear.

An important source of expense are the hazard accounts which include loss and damage from any cause whatever, insurance, investment in safety devices (more correctly, *interest* on such investment), and amount of responsibility or hazard incurred. These risks are largely covered by the law, but much leeway is left for companies to reduce their individual risks of fire, wreck, loss of life, loss of cargo, damage, etc. War risks should be carried in this account and a minor damage account for small collisions, hospital arrangements for employees, etc.

The earning capacity of a boat may be considered by dividing shipping into two groups, viz., those doing general shipping and those working for a specifice industry, and often especially constructed for that industry. The first class consists of freight and passenger ships, usually combinations of both. Freight rates are so thoroughly standardized now by agreements, commerce commissions, etc., that the cost of operation hardly constitutes a basis, especially as the export rates are largely set by foreign lines with whom we cannot compete. It should be more generally realized that a large proportion of the world's ships are owned by American capital, although flying foreign flags and running abroad. For instance, we note the Pacific Mail, Toyo Kisen Kaisha, International Atlantic Steamship Company and others.

The classification of passengers is also highly standardized, and the fares which they pay. It is a simple question of efficiency, as competition has reduced the passenger business to a question of cost versus service rendered. Things are so standardized that a passenger pays for each thing wanted, even to having a café aboard ship. All of this is based on an accurate knowledge of costs.

Specific carriers, such as colliers, tankers, ore carriers, grain carriers, lumbers carriers, refrigerator ships, high-speed passenger ships, ferryboats, and others, are built for one purpose only and can be made to operate with great efficiency because all parts can be proportioned to the one duty, men trained to this duty, and their operation reduced to a routine. Such craft are operated, usually, in connection with some industry and are entirely subordinated to the requirements of the industry. Such boats can attain greater economy than any other type of steamer, but economy is usually secondary to the requirements of the industry, which, primarily, are regular and reliable service, regardless of any other consideration, because they have large interests absolutely staked upon the regular and timely arrival of these boats.

No small part of any steamship line is that department which obtains business for them. It is salesmanship pure and simple. Pioneer boats on a new route are usually small, under charter, and run irregularly. It depends upon the sales force to develop such business into a regular route. A transportation salesman covers a broader field than any other type. He must call on all industries and bring firms in widely different territories together for mutual benefit. He must be in touch with a hundred industries. He must have general knowledge of economic conditions throughout the countries which his line connects, and successful salesmen of this type do have this knowledge in actual practice.

In making estimates for cargo or freight it is customary to have estimate blanks mentioning the more usual sources of expense, such as insurance, cost, harbor charges, pilotage, customs charges, wharfage, cartage, etc., etc. In making such an estimate, every link in the chain must be complete from the shipper to the consignee. Some shippers ship from "ship's slings to ship's slings," others from wharf to wharf, etc., according to agreement and conditions.

The design of the ships, their operation, the organization of the service, proper advertising, a knowledge of the territory served, and the co-ordination of all this effort requires executive work of the highest order.

In rehabilitating the American merchant marine no one thing is needed more than to present marine work and steamship service to young men as a career, where they can serve with honor to the highest positions, rather than a trade, in which they are knocked from pillar to post with no definite future or permanency of position.

Gain of Cargo Capacity in Motor Ship of About 3,000 Tons Deadweight Capacity

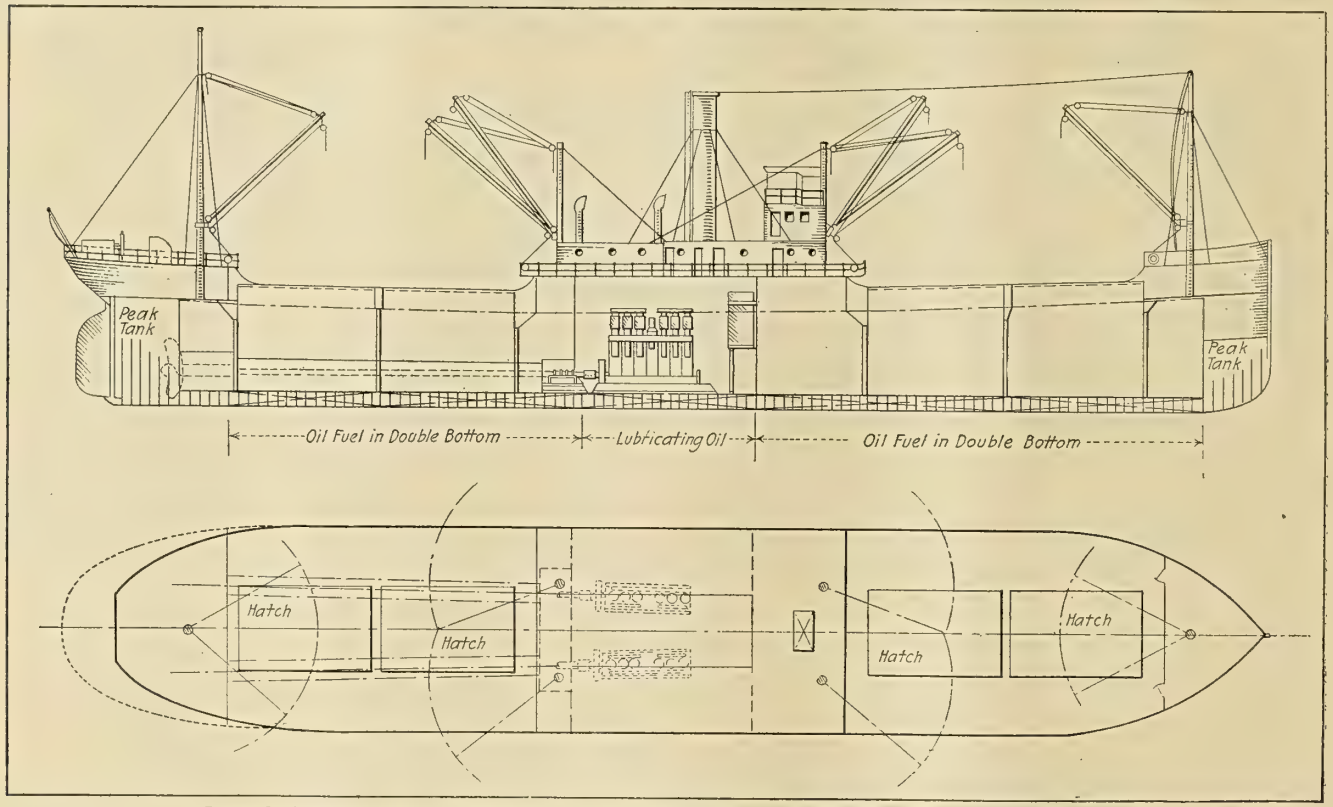
BY R. W. CROWLEY

During the period when high freight rates and full cargoes have been prevailing the shipowners have been so busily and persistently concerned with ways and means of utilizing their immediately available resources to the greatest profit that they have had no opportunity to study the continuing and increasing successes of the full-powered motor ships that are issuing steadily from the Danish and Dutch shipyards. Also the craze for installing auxiliary propelling power in wooden vessels has diverted attention from the full measure of development to a half measure of development, in just such a manner as happened during the era of introduction of steam into the shipping world.

Yet while steamers have been earning much money the motor ships have been earning even more, and this has been happening even where American owners could have noticed it had they so cared. Danish motor ships have been carrying case oil from the United States to China, and, though the figures have varied for each vessel, the general advantage is indicated by the statement that in a particular instance, for example, the motor ship carried about 40,000 cases more than a steamer of the same length could have carried, and that meant a clear extra profit of about $70,000 (£14,400) on a passage lasting about 35 days.

That the benefits of the motor ship are not, however, restricted to foreign owners, but can be seized by American owners who are operating vessels in nearby waters, is becoming recognized by the more discriminating firms, and inquiries to this end are being made in the few quarters where trutsworthy oil engines of the requisite power can be obtained.

How well a motor ship would serve in the New York-West Indies trade, for instance, is demonstrated by the comparison given in the following between a motor vessel and a steamer, both of about 3,000 tons deadweight capacity. These figures were prepared for an owner who was considering a new vessel for the log trade, and it was finally on account of the special conditions of this trade that the order for the motor ship was not placed. Upon occasion logs would have to be loaded in an open roadstead, and the danger of these fouling the propellers was adjudged to be of such weight that a twin screw installation could not be accepted, and since the engine builders were not ready to quote on a single engine of 1,000 brake horsepower the project of this motor vessel had perforce to be abandoned. In the figures, however, other shipowners may perhaps find inspiration.



General Arrangement of Twin-Screw Motor Ship of About 3,000 Tons Deadweight Capacity

This vessel measures 251 feet in length between perpendiculars (261 feet length over all), has a molded breadth of 43 feet 6 inches and a mean depth of 20 feet, the load draft being 17 feet 6 inches. To give the ship a speed of 10 knots the power required will be: Steam, 1,200 indicated horsepower; four-cycle Diesel type, 1,000 brake horsepower.

This machinery will consist of a triple expansion steam engine or of twin screw Craig Diesel type engines, and, inclusive of boilers, shafting, propellers, engine room auxiliaries, etc., as may be required in each instance, will weigh complete: Steam, 210 tons; four-cycle Diesel type, 130 tons.

On a basis of bunker capacity for 26 days steaming at five-sixths full power, and calculating 18 tons of coal per diem for the steam engine, while the Diesel type engines will consume only four tons per diem, the weight of fuel carried will be respectively: Steam, 469 tons coal; four-cycle Diesel type, 104 tons fuel oil.

Additonally there is to be taken into account the fresh water needed for the boilers, this in the case of the motor ship being for the donkey boiler. In the respective cases

these figures will amount to: Steam, 75 tons water; four-cycle Diesel type, 25 tons water.

Although the machinery of the motor ship will weigh 80 tons less than that of the steamer, the assumption will be made that perhaps only 50 tons of this saving can be utilized to increase the deadweight capacity of the ship. Thus the respective cargo capacities will be: Steamer, 3,000 tons deadweight capacity; motor ship, 3,050 tons deadweight capacity.

For the stores a weight of 12 tons may be accepted, this being the same in both classes of vessel.

With these premises one can calculate the respective capacities of the two ships on an outward passage with bunkers full and fresh water tanks replenished.

Steamer		Motor Ship
3,000 tons	Deadweight capacity	3,050 tons
469 tons	Coal—Bunkers—Oil	104 tons
75 tons	Fresh water	25 tons
12 tons	Stores	12 tons
556 tons		141 tons
2,444 tons	Cargo capacity outward	2,909 tons

With the assumption that the outward passage is made in 10 days, the steamer's cargo capacity will be increased to the extent of 180 tons, representing the coal that has been burned, but the motor ship's cargo capacity will be increased only by 40 tons, the consumption of fuel with Diesel engines being so much smaller in comparison. Thus on the homeward passage the figures will be:

Steamer		Motor Ship
2,624 tons	Cargo capacity homeward	2,949 tons

Thus the motor ship enables 465 *tons* extra cargo to be carried on the outward passage and 325 *tons* extra on the homeward run, an aggregate additional *gain of* 790 *tons earning freight* on the round voyage.

In the steamer of the dimensions here accepted the cubic capacity is 133,000 cubic feet at 42 cubic feet per ton. In the motor ship six extra frame spaces are given to the hold by the reduction of machinery space (the forward bulkhead of the engine room would actually be two frame spaces further aft than is indicated on the blueprint, where four frame spaces have already been saved from the corresponding engine room of the steamer). These six frame spaces increase the hold capacity by 8,256 cubic feet. Furthermore, in the motor ship the space occupied by the bridge bunkers of the steamer is available for cargo, this representing 334 tons at 42 cubic feet per ton, equaling 14,000 cubic feet. No benefit accrues to the motor ship through the lapse of side bunkers in the engine room, the space so yielded being required for the auxiliary engine sets. On the debit side there is a loss of about 1,000 cubic feet, due to the twin shaft tunnels of the motor ship in comparison with the single tunnel of the steamer, and about the same figure (say 1,256 cubic feet) is to be deducted for the donkey boiler space. Thus the cubic capacities of the two vessels are:

Steamer		Motor Ship
133,000 cubic feet	Cubic capacity	153,000 cubic feet

Hence the motor ship affords about 15 percent greater cubic capacity and about 15 percent greater cargo-ton capacity than the steamer. That is its greater profit.

When this percentage is translated into dollars its significance appears perhaps more pronounced. For instance, assuming a freight of coal to Havana at $3.50 per ton and a sugar cargo homeward at 30 cents per 100 pounds, then the freight earnings would be:

Steamer		Motor Ship
2,444 tons at $3.50		2,909 tons at $3.50
= $8,554	Earnings outward	= $10,185
2,624 tons at 30 cents per 100 lbs.		2,949 tons at 30 cents per 100 lbs.
= $17,633	Earnings homeward	= $19,817
$26,187 (£5,375)	Round-voyage earnings	$30,002 (£6,160)

With eight voyages per year in this trade the difference in the earnings of the two types of vessel would be 8 × $3,815 = $30,520 (£6,275) per annum in favor of the motor ship, a sum which represents extra profit and is not subject to any deductions. The vessel would probably be making other voyages in the West Indies, but since the proportion between the motor ship and the steamer freight earnings would remain substantially the same on those other voyages, the assumption of the eight round voyages between New York and Havana, which is adopted here for simplicity's sake, is reasonable and valid. The figures can be calculated for other cases if so desired, and will be found to leave the final proportions practically unaltered.

There are also other savings. Taking bunker coal today at $3.50 per ton New York, and assuming that fuel oil be taken aboard at Jacksonville, Fla., where it can be purchased at $1.50 per barrel, which is cheaper than buying in New York, even though port charges of $250 would be incurred at Jacksonville, the respective fuel costs, assuming 20 days' steaming on the round voyage, will be:

Steamer, 18 tons coal per diem for 20 days, at $3.50 per ton, $1,260; motor ship, 4 tons oil per diem for 20 days, at $1.50 per barrel, equals $720, plus port charges, $250, at Jacksonville, Fla., equals $970.

With a fuel saving thus of $290 (£59.5) per voyage to the credit of the motor ship, the annual saving on the assumption of eight voyages per year will be 8 times $290, equals $2,320 (£476).

In respect of engine room crew there will be a saving both in wages and in the food bill, the motor ship being able to dispense with the "black squad." This saving will be greater on a ship under the American flag, but it is considerable also under a foreign flag, and for the purpose of this comparison it will be supposed that the vessel will fly foreign colors. Then the manning of the engine room will be, respectively:

STEAMER	MOTOR SHIP
Chief engineer.	Chief engineer.
3 assistants.	3 assistants.
3 oilers.	3 oilers
6 firemen and messboy.	
1 donkeyman	1 donkeyman

This means a saving to the motor ship of six firemen at $40 per month, equaling $1,440 (£296) per annum, plus the wages of the messboy, making a total of $1,740 (£358). The subsistence allowance, being 50 cents per man per day, amounts to $1,279 (£262) per annum. The total saving under this head will be $3,018 (£620) per annum.

Grouping these items, it will be seen that the extra profits accruing to the motor ship through increased freight earnings by the larger cargo capacity are $35,858 (£7,380), while the savings effected amount to $5,338 (£1,100), a total difference of about $41,000 (£8,480) in favor of the motor ship.

If the steamer cost be reckoned at about $350,000 (£71,800) at the prices prevailing when these estimates were prepared, and the motor ship cost be accepted at almost $400,000 (£82,000), it will be observed that the extra profits from the motor ship are practically sufficient to write off in one year its higher capital cost, amounting as they do to more than 10 percent of the motor ship cost.

This comparison is one of the least favorable to the motor ship that can be made, inasmuch as it deals with fuel conditions that show practically no favor to the motor vessel, and the extra profits arise almost entirely from the increased cargo capacity.

A NEW ORGANIZATION, the Marine Engineers' Beneficial Association, Ocean, No. 99, has established headquarters at 11 Broadway, New York.

BUILDING WOODEN VESSELS ON THE PACIFIC COAST

Fig. 1.—Five-Masted Schooner in Frame

Fig. 2.—Shipbuilding Timber

Fig. 3.—Products of the Pacific Coast Yards

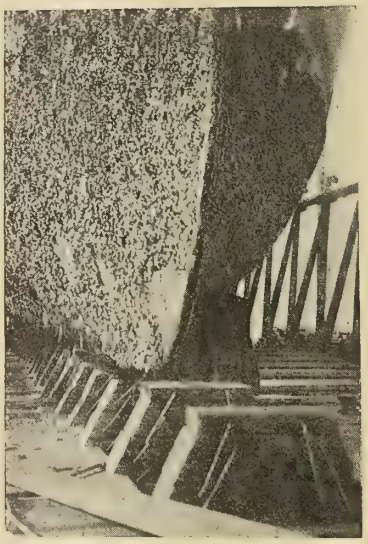


Fig. 4.—Work for the Pacific Coast Dry Docks

Fig. 5.—Making Ship's Spars

Wooden Shipbuilding on the Pacific Coast

Simultaneous Development of the Lumber and Wooden Shipbuilding Industries on the Western Coast—Decline and Revival of Wooden Shipbuilding—Growing Popularity of Auxiliary Sailing Vessels

TO give an intelligent description of the growth and development of the wooden shipbuilding industry on the Pacific coast it is necessary to outline briefly the growth and development of the lumber industry on the western coast, as the two industries were interdependent and were developed simultaneously.

The Pacific coast is the home of the largest belt of timber of commercial value in the world. The lumber belt extends continuously for over one thousand miles along the coast between latitudes 40 to 58 north, and in width approximately two hundred miles inland from the coast. For the past thirty years this timber has been extensively manufactured and shipped to all parts of the world, the most extensive market being California and rail shipments east. The principal foreign markets are New Zealand and Australia, the west coast of South America, South Africa and the Hawaiian Islands, and since the opening of the Panama Canal a large business is being built up with the east coast of South America.

In density the growth of timber on this area is very uniform, and many sections of this land will yield as high as 24,000,000 feet of merchantable lumber to the acre, the average being 6,000,000 to 8,000,000 feet to the acre. To market this product many ships are required, and as a consequence many wooden ships have been built. The timber of commercial value which this area produces consists of eight varieties, which vary according to the zone in which it is grown. In the southern latitudes the redwood, sugar pine and Port Orford cedar predominate. The redwood is not suited for shipbuilding purposes, as it splits too easily, but is used extensively for building purposes. The sugar pine is the best known variety of lumber for interior finishing, cabin work, etc., and is extensively used for patternmaking. The Port Orford cedar is considered the highest grade of lumber in the list of woods used for shipbuilding purposes, but owing to its limited supply it is no longer used in large vessels, but is largely used for yacht work, small boats and the like. Its merit lies in its extreme lightness, strength and lasting quality, which are beyond that of any wood known.

Immediately north of this belt, extending throughout Oregon, Washington and the British Columbia coast, the Oregon pine or Douglas fir predominates. This timber is the chief commercial timber of the coast, and ranks high in grade for strength, durability and the ability to secure large and long length timbers from the trees. It is an ideal timber for shipbuilding purposes, being used in lengths up to 130 feet. Keel timbers are secured in lengths of 100 to 120 feet, and in sizes of 18 inches by 30 inches to 32 inches. The lasting quality of this lumber is not to be compared with the Port Orford cedar, but a vessel built of it, with ordinary care, is good for a life of twenty-five to thirty years.

The other commercial varieties of timber grown here include the red cedar so extensively used for shingles and interior finishing, and hemlock used for building purposes and interior finish. Neither of these varieties, however, is used in shipbuilding. In the northern portion of this timber belt the spruce predominates and is used to some extent for sheathing bottoms of ships, planking for small boats, etc., but is not used in heavy ship construction, as it decays too readily when confined to permit of its use for this purpose.

In the northern portion of this belt is also found the eighth variety of wood, which is gradually becoming more extensively used for shipbuilding purposes as its value becomes more generally known. This wood is the Alaska cedar. Its merit lies in its strength, lightness and lasting quality. Ship's frames built of this material are good for one hundred years without decay, and examples can be found of vessels built of this wood by the Russian Government when Alaska belonged to that nation that are still in good condition after having been in use nearly one hundred years. This timber is somewhat scrubby in growth, and is best suited for ships' frames and timbers, as the long lengths desired in the ceiling and planking of wooden ships cannot be obtained from it. A combination of either the Port Orford cedar or Alaska cedar for frames, deadwoods, etc., in a wooden ship, with the fir for long timbers and planking, gives the best possible results to be obtained in wooden shipbuilding, and a vessel of this character will outlast the oak and pitch pine construction that has long been considered the acme of perfection in the building of wooden ships on the east coast.

In the early development of the lumber industry on the Pacific coast the first market for these forest products was San Francisco and the lower California coast, and occasionally one of the old-time square rig ships plying

between San Francisco and New York or Europe would be sent north to Puget Sound, and would, by crude methods, cut and roll into the waters of the Sound from the heavily wooded shores such logs as were most easily obtained. These were then floated alongside the ship and hoisted aboard by hand power, as at that time steam was not used on the sailing ship. These logs were then carried to San Francisco and there sawn into lumber for building purposes, as the city was then beginning to build up and develop as a result of the gold discoveries in California. Later, sawmills were established on Puget Sound, Gray's Harbor, the Columbia River, Coos Bay and other points along the coast, and the logs cut into lumber at these mills.

Single Deck Lumber Schooner

In order to transport this lumber to market it became necessary to build up a fleet of sailing vessels for the purpose. It was then found that the double deck vessel that had commonly been used in the deep sea traffic was unsuited for this lumber trade, owing to the difficulty in handling the long timbers in their holds. To obviate this difficulty the single deck vessel was developed. This at first consisted of small two-masted schooners capable of carrying 250,000 to 300,000 and 400,000 feet of lumber. These vessels were of light draft and given a broad beam, so as to carry deck loads, and in loading about two-fifths of their cargoes were stowed under the decks and three-fifths on deck. As the demands for lumber increased the size of these vessels was gradually increased, leading to the construction of four and five masted schooners and barkentines. These vessels, in size, are considered about the limit for building single deck vessels of wood. The capacity of these vessels now averages approximately 1,500,000 feet, and their trade has been extended from the coast business to Australia, South Africa and the West Coast. For Australian trade these ships usually carry return cargoes of coal from New Zealand and Australia to the West Coast, Hawaiian Islands or San Francisco.

With the growth and development of these ships the firm of Hall Brothers and their successors have been closely identified. The firm was organized at San Francisco, Cal., in 1872, by the late Winslow G. Hall, Henry K. Hall and Isaac Hall, and their shipyard was established at Port Ludlow, Wash. In 1902 the yard was moved to its present location at Winslow, Wash.

Prior to removing to San Francisco the Hall brothers had been engaged in the shipbuilding industry in Boston, Mass., and Winslow G. Hall, the designer for the firm, had had extensive experience there in the construction of the fishing vessels then so extensively used on the east coast and known as the Gloucester type of fisherman. In designing the lumber schooners for the Pacific coast trade Mr. Hall embodied in them the graceful lines, clipper bow and elliptical stern that have been so much admired in that type of vessel. As the size of these lumber vessels was gradually increased to meet the demands, the same model and graceful lines were continued throughout the entire fleet of sailing ships built by this firm.

This firm has built a larger number of wooden ships by far than any other one firm on the coast. Other firms have established shipyards at various points on the coast for building wooden ships, chief of which have been the Bendixsen Shipbuilding Company, at Eureka, Cal; Kruse & Banks shipyard, at Marshfield, Ore.; the Lindstrom Shipbuilding Company, at Hoquiam, Gray's Harbor, Wash., and the Matthews Shipyard, at Aberdeen, Wash. Hiram Doncaster, an old-time east coast shipbuilder, also established a yard on Puget Sound and built several ships at Seabeck, one of the old-time lumber ports of the Sound —since abandoned. He also built several vessels at Port Ludlow after the present mill plant was established there. Thomas Peterson, one of the old-time shipbuilders from the east coast, also established a yard and built several vessels at Port Madison when that point was one of the principal lumber ports of the Sound. The Seabeck and Port Madison mills have long since been discontinued, and the yards established there discontinued business several years ago. Crawford & Reed established a yard at

Fig. 6.—Four-Masted Schooner *Balboa*, Built by Hall Bros. in 1901

Fig. 7.—Typical Wooden Schooner (the *Nokomis*), Built by Hall Bros.

Tacoma, Wash., but have confined themselves to the building of wooden steamers, principally for the fishing trade. Charles White established a yard at Everett, Wash., and built several vessels there up to the time of his death in 1904. Since then the yard has been discontinued. Ed. Heath established a yard at Tacoma about 1902 and built several seagoing vessels, including the well-known Alaska excursion steamer *Jefferson*. He has lately removed to Seattle and is now engaged in building there. The Simpson Lumber Company, of Willapa Harbor, has built a number of vessels, principally for their own use in their extensive lumber business. This yard has discontinued building since Mr. Simpson's death several years ago. Several vessels have also been built at San Francisco and Oakland, Cal., by Middlemast & Boole, Mr. Boole individually and by Stone's Shipyard.

Collectively these firms have built wooden ships in number equal to those built by the Hall Bros. Company, extending over an equal period of time.

This comprises the extent of the development in wooden shipbuilding to date on the Pacific coast.

Decline of Wooden Shipbuilding

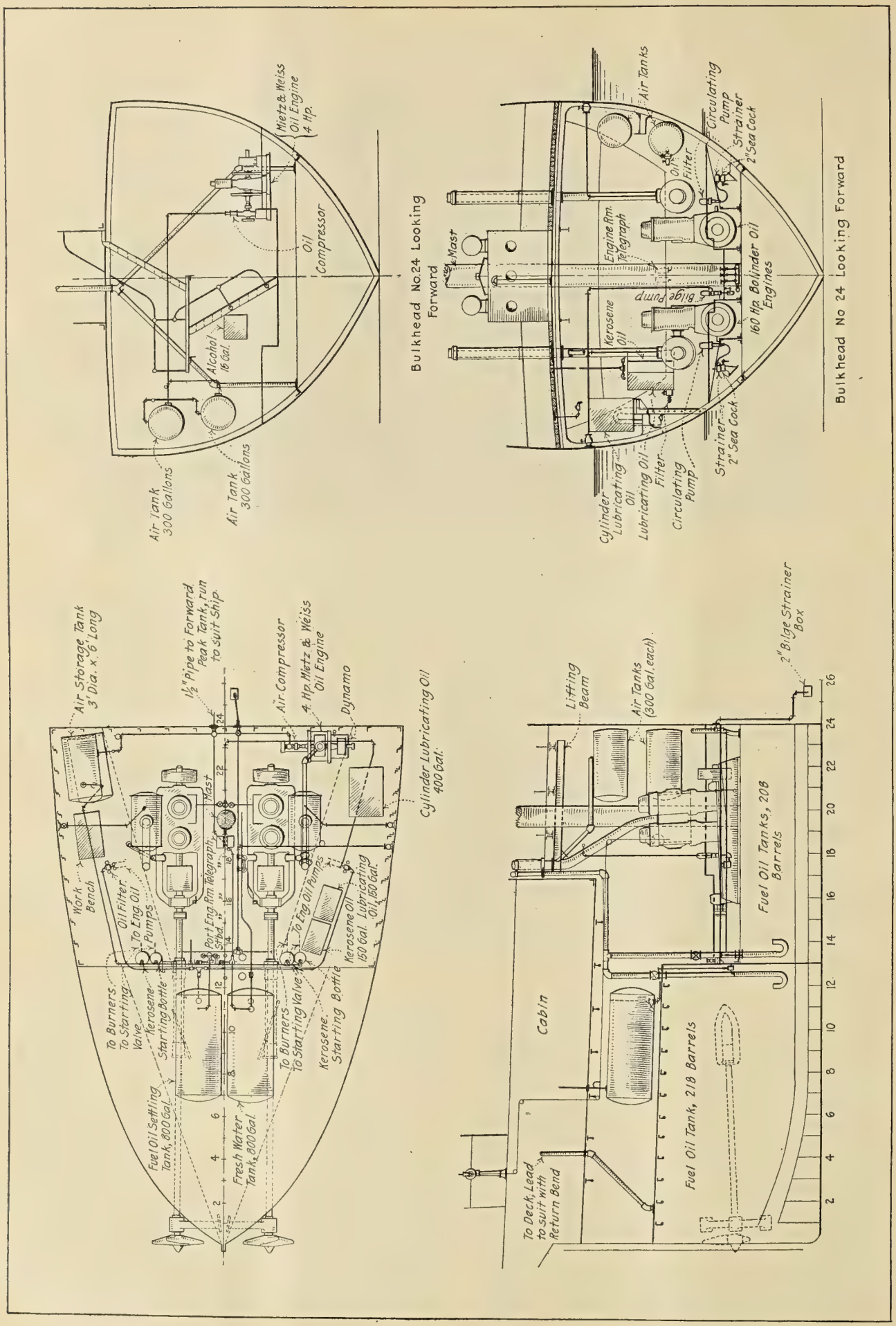
Since the Hall Bros.' plant was established at Winslow in 1902 no sailing vessels for the lumber trade have been built on the Pacific coast, and the business for ships of this class has gradually declined, owing to the large number of tramp steamers coming to the coast that could carry lumber to foreign ports at a rate below what it would pay to carry it on the sailing vessel, particularly the small type, so that none of the wooden ships now remains in the lumber trade except those of the larger capacity. The smaller vessels have gradually disappeared by loss or through being diverted to other lines of trade, such as fishing and trade on the Mexican coast and the coast of Peru, where vessels of this character are still found profitable to operate.

Replacing the wooden sailing vessel for the coast lumber trade, the type of vessel known as the steam schooner has appeared, and in the past twelve years a large number of these vessels have been built.

Power Craft Predominate

Except for the temporary boom due to the European war, it is believed that the era for the construction of wooden sailing ships on the Pacific coast has practically passed, and that the shipbuilding firms who desire to continue in the shipbuilding line will ultimately be compelled to take up steel construction or go out of business, as the demand now seems to be for steel vessels of large tonnage—too large, in fact, to be built of wood in a practicable manner. Vessels 250 feet in length are considered about the maximum size for a wooden ship with single deck, as a larger vessel built of wood is apt to show structural weakness due to its own weight, and the difficulty encountered in securely fastening the structural members together to maintain the excessive strength necessary in that size vessel. Of course small wooden vessels, such as are used by halibut fishermen and small trading schooners for Alaska coast and Arctic trade, will still be built, but these vessels could hardly be classed as ships.

Gasoline (petrol) power has become so commonly used of late that practically all of the small vessels referred to are now fitted with auxiliary gasoline (petrol) engine power. At present there is being built on the Pacific coast one auxiliary powered wooden sailing vessel intended to carry a lumber cargo of 2,000,000 feet board measure. This vessel is being built for the McCormick Lumber Company, of San Francisco, by the St. Helens Shipbuilding Company, at St. Helens, Ore. Her length is 286 feet over all and the beam 42 feet. One other wooden auxiliary powered sailing vessel has been contracted for by the Matthews Shipbuilding Company, of Hoquiam, Wash., and will be of about 1,500,000 board feet lumber capacity. This vessel, if properly designed, should be a practicable ship. The Matthews Shipbuilding Company also had

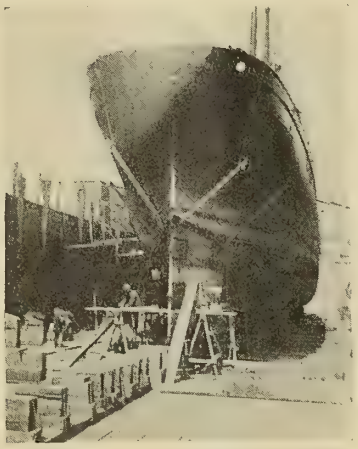


Plans of Machinery Space in Auxiliary Schooner *Annie Johnson*

under construction a wooden steam schooner intended for the coast lumber trade. Numerous inquiries are of late being made for auxiliary powered sailing vessels built of wood, but aside from the two vessels mentioned none has developed to the point where their construction is assured.

As indicating the present tendency in the development and use of auxiliary power in the sailing vessel, it may be stated that in all of these inquiries the proposition of installing either gas engines or crude oil engines is considered, so that it is very probable the sailing vessel of the future will be incomplete without the installation of this equipment. It is calculated that by the installation of small power of this character the vessel would often be enabled to move out of the calms that they frequently encounter in off-shore voyages, and thus be able to make much better despatch in their voyage as a whole.

The Oregon pine or Douglas fir timber as grown in the Pacific coast district provides the best spars for ships that are grown in any part of the world. These timbers are selected standing in the woods where grown. The ordinary schooner mast requires a log approximately 36 inches in diameter at the butt and 24 inches to 26 inches in diameter at the top end, and from 100 to 110 feet in length. What is commonly called the bald-headed schooner, as occasionally rigged out on the Pacific coast, requires a spar of the above size ranging from 125 to 130 feet in length. Such spars are readily secured in the forests from one-length timber. These spars, however, are gradually becoming more expensive, as since the timber near the shore is being cut away they have to be brought to the Sound by rail over crooked roadbeds where frequent wrecks in handling timbers of this length occur. It requires at least three cars to carry a load consisting of three of these spars, and in the extreme curves on the roadbeds these loads often overhang the track so far that they tip the cars off the track. For this reason the price of these spars has advanced very materially in the past few years, so that at present one of these spars installed complete in one of the lumber schooners, including all rigging work in connection with the installation, costs from $400 to $450 (83/6/8 to 93/15/0).



Auxiliary Schooner Annie Johnson

Iron Barque Built in 1872—First Converted Into a Schooner and Finally Equipped With Heavy Oil Auxiliary Engines

BY EDWARD O. PERKINS

The barque *Annie Johnson,* built in 1872 and converted into a schooner in 1880, was fitted in April at the Union Iron Works, San Francisco, with two 160 horsepower Bolinder engines. The ship is built of iron and is in remarkably good condition. The principal dimensons are as follows, Length overall, 212 feet 1 inch; length between perpendiculars, 203 feet; beam, extreme, 34 feet 1 inch; beam, molded, 34 feet; depth, molded, 22 feet 3 inches.

A deep tank was built in the extreme after end from the stern post to frame 13, and another tank 7 feet deep from frame 13 to frame 24. The top of the 7-foot tank forms the floor for the engine girders, and is amply braced and stiffened with 8-inch by 3-inch channel beams clipped to the center keelson and with intercostals under each engine frame.

The mast, which formerly rested on the center keelson, was restepped onto the 7-foot tank top. The frames were cut in way of the tank tops, and bracketed with ½-inch brackets.

The capacity of the deep tank aft is 243 barrels and of the 7-foot tank 216 barrels, making the total fuel-carrying capacity 459 barrels of oil.

The propeller struts are of cast steel, fastened to the ship with tap bolts the heads of which were electrically welded. This was made necessary because of the extreme fineness of the vessel, which made it impossible to rivet through the shell at that point.

The auxiliary power is provided by two 160 horsepower crude oil marine type engines, built by J. & C. G. Bolinder, Stockholm, Sweden. Each engine has two cylinders, 16½-inch diameter by 18¾-inch stroke. The overall dimensions of the engines are: Length, 13 feet; height, 6 feet; width, 4 feet.

Each of these engines, complete, weighs 230 cwts. and develops 160 horsepower at 225 revolutions per minute.

The vessel is equipped with a 4 horsepower Mietz & Weiss oil engine, direct connected to an electric generator and an air compressor, built by the Herzog Electric & Engineering Company of San Francisco, Cal. A bilge pump and circulating pump are furnished by J. & C. G. Bolinder Company in connection with the main engines.

There are two three-bladed propellers, 6-foot diameter and 4-foot 1½-inch pitch. The expanded area of each propeller is 11.92 square feet, the projected area 10.95 square feet and the disk area 28.27 square feet.

Scientific Studies Applied to Riveting

Cost of Riveting in Ship Construction Analyzed—Importance of the Labor Problem—Methods of Reducing Costs

BY WILLIAM M. KENNEDY

Owing to the wonderful advances made in the fundamental principles of scientific management in the past few years, it will be interesting to note some of the accomplishments in different operations in a shipyard.

The following astonishing result obtained by Mr. Frank B. Gilbreth may be interesting to recall. Mr. Gilbreth by applying "motion study" to bricklaying, one of the oldest trades in existence, increased the daily output from 1,000 to 2,700 bricks. This largely increased output was not obtained by speeding up, but by careful scientific study which revealed the lost motions, thereby removing the obstacles to production which annoy and exhaust the workmen.

If such inefficiencies can be shown to exist in one of the oldest trades, what are the conditions of the later-day trades? I particularly refer to pneumatic and hydraulic riveting. Although many improvements have been made by structural workers and shipbuilders in this trade, the output at the point of the tool has not increased in proportion to the improvements in equipment of the standards established by the manufacturers of rivets.

Standards and Improvements Required of Material and Equipment

The manufacturers of rivets provide the following information in an effort to excel and meet the requirements demanded of their product. The chemical tests determine the quantities of phosphorus, manganese, sulphur, and carbon; the physical tests reveal the elastic limits, elongations, shearing strength, tensile strength, etc. The manufacturers of equipment are producing more efficient machines or improving present ones; better types of heating forges have been devised, among them being the rivet oil forge. Manufacturers of hydraulic riveting machines consider even the economical use of water by their machines—after the rivet is driven the water returns to the tank and is used again. High speed air hardening steel dies are being used successfully in hydraulic riveting machines. These dies drive from 40,000 to 50,000 rivets without redressing. It is only by constant study and tests, aided by staff specialists †, that these improvements are possible. Mr. Hamilton Church in "Production Factors" states, "If profit is to be made anywhere in manufacturing it must be made at the point where the tool touches the work."

By tests and analysis rivets are proven to meet all requirements; equipment is efficient and constantly improving, but the output—the key to economical shipbuilding and profits—is lacking. Output for riveting is at the same stage at present as bricklaying was before Mr. Gilbreth showed the doubters how it could be done.

Magnitude and Elelments of Riveting; Standard of the Minor Elements

When one realizes that riveting is the most costly single operation of the structural portion of shipbuilding, representing approximately 30 to 45 percent of the total cost of labor (according to the type of ship), it can be readily understood what a remunerative field is open to the attacks of scientific studies.

Cost of riveting is composed of the following:

(1) Direct labor (wages of productive labor only).

(2) Indirect expense (comprising interest, depreciation, maintenance, power, and a portion of supervision, organization, tool charge, oil, waste, etc.).

(3) Material (cost of rivets, which absorbs freight charges, handling, and a portion of stores charges).

Of these three elements*, the cost of the first is the greatest, being equal to or greater than the cost of the second and third. Yet laboratories are fitted out, chemists employed, expensive machines purchased for tests, staff specialists engaged, all in an effort to standardize and improve material and machines, the minor elements of riveting. All this has been proven to be economical and remunerative. Why, then, is labor, the most expensive element of riveting, allowed to drift along unstandardized?

Analyzing Operations; Chemical Test of Fuels; the Proper Forges

We can begin by taking the elements of each operation, comprising riveting, and arrive at some of the existing conditions that are in doubt, then by constantly seeking with an open mind a better method of performing every elementary operation by intensified observation, research, and study into domains largely unexplored, present methods can be improved until, behold! a "Gilbreth" to master the art of large output, with less effort, is found.

The question of the most suitable fuels, owing to their effects on the various ingredients contained in a rivet, should be determined by chemical tests. From information obtained by the tests, the most suitable and economical fuel for all conditions and localities could be determined.

Fuel decided by conditions will be discussed with forges.

The price of fuels varies considerably in different localities; therefore, where the tests show two or more fuels to be equally suitable for certain classes of work, the lowest priced can be purchased with a secure feeling of not having sacrificed efficiency for economy.

As the economical features of riveting are being discussed it will not be out of place when considering forges to consider the indirect expenses due to the uses of different types, as oil, air, and hand forges. Each type represents an investment, the former being the most expensive, and when considered as a "productive factor," † the hourly charges due to its use make this type adaptable only to work for which it is designed to be used, that is, in connection with machines that drive large quantities.

The portable air forge with its limited output and slightly lower charges is well suited to work where the demand for quantities is not great. Its advantage over the first type is slightly lower charges. If oil forges were

† This function is clearly defined by Mr. Harrington Emerson in "Efficiency as a Basis for Operation and Wages."

* Under the present cost accounting system or averaging methods, the cost of labor is much greater than the sum of indirect and material costs, by the production center method of assigning any expense that has a definite relation to a machine (a machine being a producing unit), quite different results would be obtained.

† See Mr. A. H. Church's "Productive Factors."

used when the second type will supply the demand, it is very apparent that the difference in hourly charges is wasted.

Considering interest, depreciation, and maintenance on forges, hose and connections for the first two types, also the cost of power and fuel, it can be readily seen how much higher the costs are over hand forges, and yet hand forges can be successfully used for certain classes of work. Hand forges can be shifted quicker and easier than other forges, so become indispensable for odd work; their idle time, while being wasted, is not so great. The saving to be gained by using the right forge in the right place, while small, will add to the economy of riveting. The aim should then be to use the forge carrying the lowest burden, or hourly charge, that can have a hot rivet always ready when wanted.

Method of Deciding on Right Machines

Of the several different kinds of riveting machines, which of the following is most economical and adaptable for your work—hydraulic machine, hydro-pneumatic machine, pneumatic lever machine, pneumatic toggle joint machine, pneumatic compression yoke riveter, pneumatic hammers or hand riveting?

The machines are made in any size, each designed for definite uses, each machine being best for only one certain class of work, as no machine can be adapted to all classes of work, and as it is the machine that gets the blame for failure, not the varied uses to which it has been put; thus by determining the right machine and using it only for its designed purpose, the expense of failure will be avoided. No one would expect a riveter to perform electrical and plumbing work equally as well as the work of his own vocation, so why expect the same of a machine?

Only by careful motion studies and expert cost accountants can the question of which is the best machine be answered. A motion study will reveal many things, among them being the right machine, the right man, the pounds pressure for the most economical work, pounds pressure for a pneumatic hammer requiring the very least effort on the part of operator to drive a rivet, effects on a workman when work is not ready (as bolted, reamed, stages ready, etc.), to what extent protection from the sun and blowers for closed compartments should be provided—taking into consideration that the machines carry an hourly burden, idle or in use. The above are a few of the many considerations affecting lower costs.

The cost accountant—so essential to management—should furnish the hourly burden on machines, and knowing the producing capacity, the matter of the right machine is solved.

With the many types of machines on the market and the manufacturer's willingness to experiment, no trouble will be experienced in getting the right tool. A pneumatic compression yoke riveter appears the logical machine for reducing costs. First, the number of rivets that can be driven with this type of machine is far in excess of the output with pneumatic hammers, the method by which most rivets are driven. Second, highly skilled labor is not required.

Efficient Methods

At the Pennsylvania Steel Company's works, Steelton, Pa., pneumatic yoke riveters handled by three-ton electric cranes are used. Very little bolting of the work is required. As the riveter seems to draw work up, no plate-closing device is attached to the machine. Work is laid horizontally on horses and 20 to 25 rivets are taken out of the fire at once and thrown on the girder. They are placed in holes, point down, one or more ahead of the machine at all times. Before this lot is used up, or the last ones get too cold to drive, fresh ones are ready. The furnaces are placed between the main crane runway, thereby occupying practically no floor space.

These furnaces resemble somewhat the usual blacksmith's furnace with a comparatively small chamber, they are fired with coal and have automatic stokers; about 80 rivets are placed in the fire at one time and taken out in quantities as heretofore described.

Uses of Compression Riveting Machines

Practically all structural work on the ground could be driven with this type riveter, except the center of large bulkheads.

As for the methods of holding machines, there are many light portable cranes adaptable for this work, which will allow riveting to be done at place of assembling as at present with pneumatic hammers. There is no reason why the work of yoke riveters should be confined to ground work, providing machines with sufficient reach and gap that are light enough for handling aboard ship are designed—even structural workers are using light yokes for field work, eliminating one man in the gang. The keel and center keelson could be lined and faired up, then driven with the yoke riveters. There need not be any unnecessary delay by this method, as no other work should be put down until the keel is absolutely faired and checked. Floors are driven on the ground, so after placing them and bolting to bottom plating, intercostal longitudinal clips to floor and inner bottom, also clips of floors to center keelson, can be driven, stringers, breast hooks, beam brackets, bilge keels, hatch and deck house coamings, waterway of top deck to shell, tie plates, etc., can be riveted by this method. The "Isherwood system" of longitudinal framing with the many built-up girders, transverses, stringers, and longitudinals offers every opportunity for compression riveting.

Have a special gang to rig up frames*, supports, cranes, and trolleys. Do not let machines stand idle while riveting gangs adjust support. Idle machines steal your profits. Functional management, with one man or gang doing one thing, is the keynote to efficiency.

Some Methods to Assist in Meeting Competition

Cutting down the operating cost of riveting is by no means new, nor are the ideas or methods new, but as the same old methods prevail they will be immediately pointed out as being impracticable. Why? Because shipbuilding methods in the United States have got into a rut—so to speak.

Not only are these methods practicable and absolutely certain of being put into effect in the near future, but it will not be surprising to see plating put on a strake at a time and secured by yoke riveting.

Fabricating structural work on the ground has been a means of large savings, and a greater percentage of a ship can be thus assembled by employing a special mechanic to develop the extension. The saving will more than offset the expense.

An article appeared in one of the Philadelphia newspapers recently on the relative cost of shipbuilding here and abroad, bringing out the fact that shipbuilders in the United States are not able to compete with foreign producers. Riveting being the most important single subject, it can be taken first and mastered in all its details, then let the minor subjects follow. The reduction in cost that

* Pipe frame and balance lever supports for this type of work are manufactured by Ridgely & Johnson Tool Co., Springfield, Ill.

would naturally follow this would be a big help toward meeting competition.

Value of Tests and Investigations

The lack of pioneer work, tests and experiments in most shipbuilding plants is most conspicuous by its absence, as compared for instance with the Pennsylvania Railroad, which maintains a department of tests, the yearly expenditures for which pass the million mark; yet the money is considered well spent. The Champion Rivet Company,* in a pamphlet, furnishes data from the various tests of their rivets, and finish with articles on how to heat and drive rivets. As a further illustration that it saves money to spend money, a few of the accomplishments in various trades are quoted, all being more or less familiar to men interested in "management."

(a) When applied to the simple operation of loading by hand a railroad car with pig iron, the performance of the individual worker increased from 12.5 to 47 tons per day.—F. W. Taylor.

(b) When applied to shoveling coal, it doubled or trebled the performance of the shoveller.—F. W. Taylor.

Mr. Gilbreth says of Mr. Taylor: "Much toward standardizing the trades has already been done. In this, as in almost countless other lines of activity, the investigator turns oftenest with admiration to the work of Frederick W. Taylor. It is the never ceasing marvel concerning this man that age cannot wither or custom stale his work. After many a weary day's study the investigator awakes from a dream of greatness to find that he has only worked out a new proof for a problem that Taylor has already solved."

(c) When applied in the manufacture of cotton goods, it increased the output 100 percent.—Scheel.

(d) When applied in the manufacture of machinery, 75 men in the machine shop, with 20 men in the planning department, do two or three times as much work as 105 men in the machine shop did under the old methods.—Hathaway.

(e) The standard study has increased the average life of belting more than sixfold; has reduced belt failures to 1-6 of what they were and has decreased the known cost to less than 1-7.—Emerson.

Shipbuilding work can be standardized to the same degree that has marked the increased efficiency in other lines of effort by applying "scientific management," as present writers have termed these "scientific studies and investigations." "The Art of Estimating," by Naval Constructor William B. Ferguson, U. S. N., recently published by the Engineering Magazine Company, deals with the standardization of shipbuilding operations.

Efficiency Records of Workmen.

Without keeping records of daily outputs, it is impossible to tell if a gang is doing a fair day's work. Many workmen bluster around and seem exceedingly busy with their many useless motions, while others watch the boss and appear busy at the right time; then there are the men whose motions are slow and methodical. Which are the most impressive? The first two, by all means, but begin and keep records and see the result. Low efficiency will be readily detected by observing the daily records; reward or punishment can be given with a feeling of having done justice, and both the employer and employe will benefit by the increased efficiency when the men realize they will be rewarded for merit.

A simple basis to arrive at the percentage of efficiency is to take a gang's earnings and divide it up according to the division of pay, then divide the individual earnings by the per diem pay.

If a gang's performance is counted daily and entered on "individual efficiency records," the records to extend over a period of one month, sheets will show at all times the daily efficiency, also the attendance records. The attendance record can be divided into "leave with permission," "leave without permission," "bad weather," and "total days worked." Each of the four, divided by working days of the month, will give percentage.

Relative Cost of Two Jobs; One by Day Work and the Other by Piece Work. Total Rivets, 117,000

(*See Curves*, Fig. 1)

The curves (Fig. 1)* do not represent anything more than an average cost. The number of rivets are abscissae and the cost of rivets ordinates. On any one line the ordinate divided by the abscissae will give the same unit cost. As both the jobs, one by piece work and the other by day work, are identical in number and conditions, the lines give a graphical idea of the relative cost of day work and piece work.

The first dot and dash line, measured along the ordinate *A*, gives the total cost of job, direct labor, piece work; the unit cost being $\frac{2{,}780}{117{,}000} = 2.375$ cents. The first full line, measured along the ordinate *D*, gives the total cost of the job, direct labor, day work; the unit cost being $\frac{3{,}830}{117{,}000} = 3.275$ cents. As eminent an authority as Mr. Church,† in his discussion of the Halsey, Rowan, Emerson, Gantt and straight piece work methods of bonus payment, ignores this fact; the difference in this case being nearly 38 percent.

Overhead expenditures on this job were prorated by percentage for the entire shop; in this average being included, hand tool men, pneumatic tool men and men using expensive machinery. The total overhead divided by total labor at this time giving an overhead expense of 35 percent of labor, the result being that sums of $1,340 and $973, respectively, were distributed to the day work and piece work jobs. This is represented by *G* and *H* on the curves. By taking 35 percent of the direct labor unit cost of rivets, the indirect expense per unit as above will be found showing that the overhead, by this method, varies according to the direct labor cost per unit.

When a riveting gang is considered as a production center and the factors reduced to an hourly basis, the ordinates *B* and *F* represent work's costs for piece and day work. *B* minus *A* and *F* minus *D* will give the overhead charges due to the machines being burdened with an hourly charge of 60 cents.

By using the percentage method of distribution, *C* for piece work and *F* for day work, is the portion of overhead not distributed to its proper source. The production factor method of burden includes all the expenditures due to the operation of a production center, such as land factor, interest and capital outlay, depreciation, repairs, power, fuel, oil, waste, a portion of tool room charges, supervision and general charges. A machine then carries a constant hourly charge, idle or in use; idle time being carried as a supplementary rate, which should

* Some valuable facts and varied practical opinions on driving and heating steel rivets are published by the Champion Rivet Company, of Cleveland, Ohio, in a pamphlet edited by them.

* When referring to work's cost, direct labor and overhead charges are included. Cost of material, although part of work's cost, has been intentionally left off to compare direct labor and overhead.

† "The Science of Management," by Mr. A. Hamilton Church.

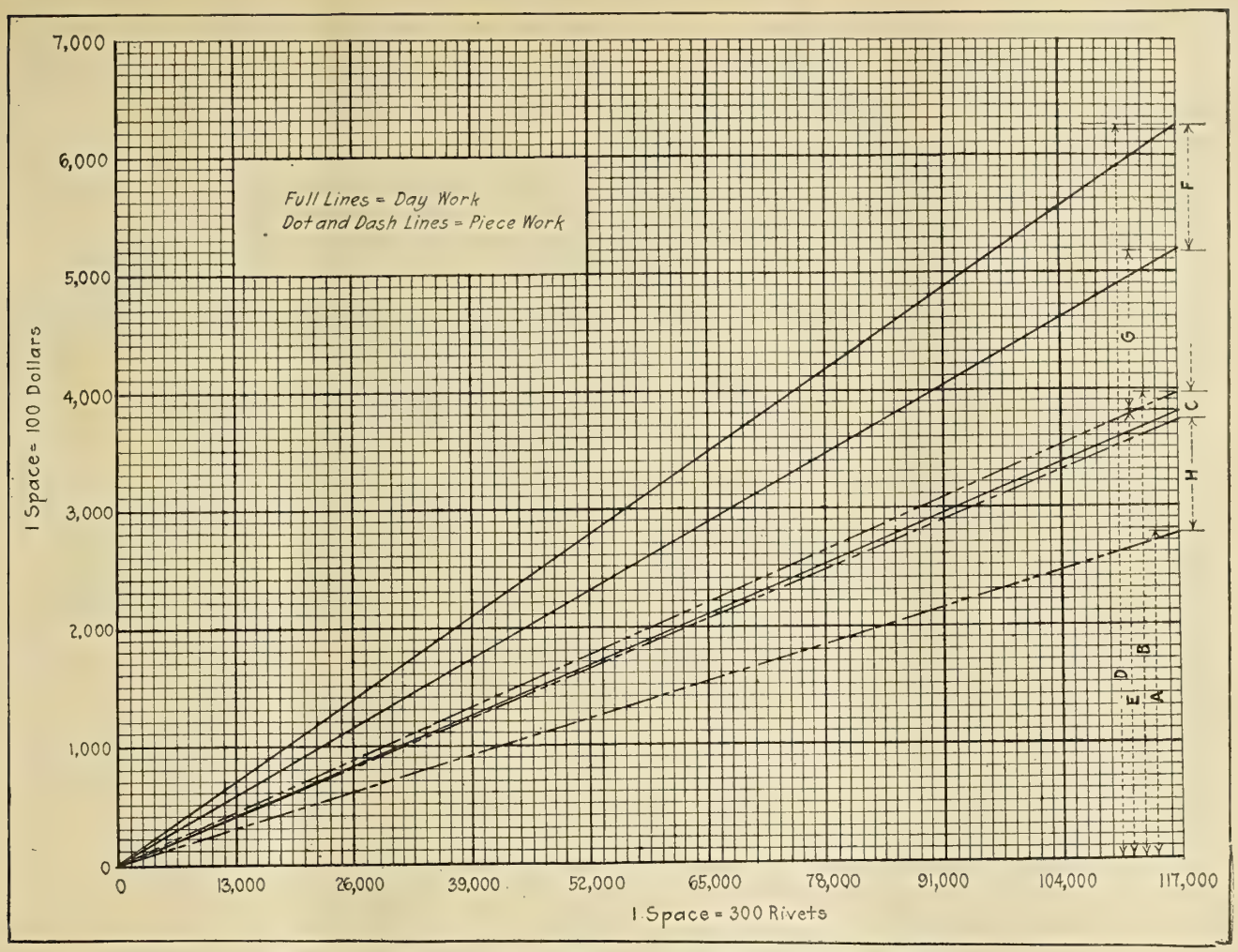


Fig. 1.—Cost Curves for Driving Rivets by Day Work and by Piece Work

be charged to profit and loss, and not prorated; as it has served its purpose when the amount is known and can be compared to periods. Hence, each production center then pays its portion of charges when the percentage method is eliminated.

Piece Work Accomplishments

On piece work the largest average efficiency obtained by a gang was 161 percent, or 61 percent over day's pay. average earnings for all gangs being 50 percent over day's pay, average pay being $11.20 per diem (this includes passer boys, who do not share in piece work); $2,780 total cost, divided by 11.20 = 248 man-day's of 8 hours or 1,984 man-hours, at $.60 (hourly burden) = $1,190.40.

Day Work Costs

$3,830 total cost, divided by $7.60, average daily pay of day work gang, = 504 man-days or 4,932 man-hours, at $.60 = $2,419.20 overhead charges.

Comparisons

Piece Work

Direct labor, cost per rivet in cents	2.375
Overhead labor, cost per rivet in cents	1.02
Number of man-day's work	248
Average daily performance (rivets)	472

Day Work

Direct labor, cost per rivet in cents	3.275
Overhead labor, cost per rivet in cents	2.07
Number of man-day's work	504
Average daily performance (rivets)	232

Results

A saving of 38 percent in direct labor with gangs' earnings 50 perecent over day's pay, a net saving of 103 percent on overhead and a saving of slightly over 50 percent on work's cost. Number of day's machine time less than ½ and daily gang performance more than double.

Reducing Cost by Checking Records

For estimating purposes and a check on work, a checking sheet can be made and kept up at a very small cost. The checking sheet used on the piece work job previously discussed is shown on page 412. No attempt has been made to alter or perfect the sheet; it is shown exactly as used, with all its imperfections.

The different classes of riveting are entered in column, "Description of Work," checking being done in a horizontal line opposite each class, the date and number of rivets driven being checked off; to economize space the checking is made in the form of a fraction, month and day being the numerator, the number driven, the denominator.

Example, $\frac{5\text{-}10}{4\text{-}20}$, i. e., the fifth month tenth day 420 rivets; unit prices are then entered from the piece work schedule, the number of odd rivets estimated and the amount of ground riveting determined. Thus the cost is predetermined; estimating the number of odd rivets is simplified, if accurate past records have been kept, it will be noted under operation 48 that the estimated number of odd rivets is 2,000, whereas only 179 developed, showing that past records and judgment were far from accurate.

J.O. A-L / 7 K
Date
Begun
Complete

Specifications
Provide and drive all Rivets
G = Ground Work
S = Ship "

117,843 Estimated No.
117,475 No. Driven
368 Diff.

Estimated No. Odd Rivets 2,000
Actual No. 179
Diff. 1,821

Oper No.	Oper	Allow	Unit	Unit Price	No Units	Total Price	Symb	Class	Size	Description of Work
1	Rv.	0	Rivet	0.0175	9.048	158.34	G	2	5/8"	Riveting B.H.(on Ground)
2	do.	0	"	"	1026	17.96	G	1	3/4	3/4" Rivets Top of Girder Plate, on Ground
3	"	0	"	"	1666	24.99	G	1	5/8	Rivets in Angle under Deck to Truss, on G.
4	"	0	"	"	846	14.81	G	1	3/4	Rivets to Truss Angle at Top
5	"	0	"	"	720	12.60	G	1	3/4	Brackets in Trusses
6	"	0	"	"	432	7.56	G	1	3/4	Butts and Laps in Bottom Truss Plates
7	"	0	"	"	618	10.82	G	1	3/4	Bottom Truss Angles
8	"	0	"	"	416	7.28	G	1	3/4	Angles Bottom C.L. of Truss
9	"	0	"	0.015	1074	16.11	G	1	5/8	Angles top of Truss to Deck Beam Clips
10	"	0	"	"	674	10.08	G	1	5/8	" " End of Side Truss to Deep Brackets
11	"	0	"	"	1600	24.00	G	1	5/8	Angle Top of Floor to Truss
12	"	0	"	"	316	4.74	G	1	5/8	Deep Brackets to End Brackets & End Brac. Clips to Deck
13	"	0	"	"	216	3.24	G	1	5/8	Vertical Angles to Deep Brackets
14	"	0	"	0.0175	2142	37.49	G	1	3/4	Beam Brackets to Beam & Clips to Beam
15	"	0	"	0.0175	2856	49.98	G	1	3/4	Brackets Channel Floors to Angle Framing
16	"	0	"	0.02	272	5.44	G	2	3/4	Fender Butts Straps
17	"	0	"	0.0175	720	12.60	G	1	3/4	End Framing
18	"	0	"	0.015	1596	23.94	G	1	5/8	Angles to Flashboard Brackets (Deck Flange of Clips
19	"	0	"	0.025	252	6.30	S	5	5/8	Rivet Collar to BH. on Ship. not included)
20	"	0	"	0.0275	576	15.84	S	5	3/4	Truss to B.H. Clips
21	"	0	"	0.02	96	1.92	S	3	3/4	End Laps C.L. Truss
22	"	0	"	0.025	900	22.50	S	5	5/8	Clips C.L. of Truss including Flange to Floor
23	"	0	"	0.025	1980	49.50	S	5	5/8	Clips to Side " " " " "
24	"	0	"	0.025	612	15.30	S	5	5/8	" " " & C.L. Truss at Top (Beam Flange not
25	"	0	"	0.02	704	14.08	S	3	5/8	Side Truss & all Connections included)
26	"	0	"	0.02	1224	24.48	S	3	5/8	Beam Brackets to Frame
27	"	0	"	0.0225	10974	246.92	S	3	5/8	Decks
28	"	0	"	0.02	20314	406.28	S	3	5/8	Decks
29	"	0	"	0.02	1144	22.88	S	3	5/8	Rider Plates to C.L. Truss Angle & Floor
30	"	0	"	0.0225	6954	156.47	S	4	5/8	Shell, Side
31	"	0	"	0.25	7312	182.80	S	4	3/4	" , "
32	"	0	"	0.028	160	4.48	S	4	7/8	" , "
33	"	0	"	0.0225	19392	436.32	S	4	5/8	Shell, Bottom
34	"	0	"	0.025	4648	116.20	S	4	3/4	" , "
35	"	0	"	0.0275	9630	264.82	S	5	3/4	Fender including End and Corner Casting
36	"	0	"	0.02	576	11.52	S	3	3/4	End Framing to Channel Floor
37	"	0	"	0.02	160	3.26	S	3	3/4	Clips to Bottom Brackets of Frame No. 2, 3, 52, 53.
38	"	0	"	0.0175	949	16.61	S	3	5/8	Angles, Tie Plates Brackets, (Beams & Clips to
39	"	0	"	0.0225	416	10.40	S	5	5/8	Coal Scuttles Lower Deck)
40	"	0	"	0.036	16	0.58	S	5	1	Davit Step
41	"	0	"	0.0275	32	0.88	S	5	3/4	Chain Pipe
42	"	0	"	0.031	72	2.23	S	5	7/8	30" Cleat
43	"	0	"	0.038	32	1.23	S	8	3/4	Roller Chocks
44	"	0	"	0.0225	160	3.60	S	3	3/4	Bitt Foundation Angles to Deck
45	"	0	"	0.038	264	10.03	S	8	5/8	Clips to Bitt Chuck, Roller Chuck, & Mooring
46	"	0	"	0.025	56	1.40	S	5	5/8	Pad Eye for Stowing
47	"	0	"	0.05	420	21.00	S		5/8	Rivets in Flash Board J.O. A-3 / 11
48	"	0	"	0.07	2000	140.00	S		5/8 & 3/4	Odd Rivets
					117,843	2630.74				2630.74 / 117,843 = 0.0223 Unit Price

5-6 840 | 5-9 610 | 5-22 304 | 5-23 1400 | 5-24 2200 | 6-2 600 | 6-4 1411 | 6-9 1004 | Total 9,029

Records from Checking Sheets

	No. of 5/8"	No. of 3/4"	No. of 7/8"	No. of 1"	Total No.	Total Cost	Unit Cost	Per Cent of Total Rivets
Ship Rivets	53,681	36,261	236	16	90,194	$ 2,225	0.025	0.7675
Ground Rivets	16,890	10,212			27,102	442	0.0167	0.231
Odd Rivets	89	90			179	13	0.07	0.0015
Totals	70,660	46,563	236	16	117,475	(1) 2,680	(1) 0.226	

(1) Pay of Passer Boy's not included

Fig. 2.—Checking Sheet

Column (1) is operation number, this number is used in addition to the job order number on time cards, return costs being made by operations in addition to total costs by job order. Counting from the left column, 2, 4, 5, 6, 7, 8, and 10, are self-explanatory. An explanation of column 3, allowance, and column 9, class, will not be given, as they are not essential for understanding the sheet, although these columns were used in connection with piece work schedule and are fully described on pages 38, 39, 40, and 44 in the book by Mr. William B. Ferguson, previously referred to.

The sheet on which daily entries are made is pasted to the right of the blue printed sheet. Counters turn in the previous day's work before 9 A. M. to the official in charge of work, who checks off the performance and makes out time tickets to cover completed work. Time tickets are then sent to accounting officer.

When any great variation between the estimated numbers and actual numbers occurs, the reason can be thoroughly investigated, which will show that the estimated number is incorrect or that riveters have been getting two for one, or three for two, in close places. The checking therefore becomes a protection and shows just what occurs.

Sheets covering the entire job were made up in this form and the work counted and checked. The increased production was actually surprising, due to every employe's daily performance being daily scrutinized by some one in authority. The entire cost of this preliminary work, including the ordering of material, was 7-10 of 1 percent of the direct labor cost. As this is the first work of this kind ever attempted, it is believed that this cost can be materially reduced by continuing and the men becoming more proficient. The checking sheets are useful to the management in the following ways: Unless you know what was done on the last ship, no comparisons can be made (not considering as comparisons the results obtained by dividing the riveting costs by the supposed count, with no check). It is characteristic of the human nature to try and excel past records, so by making these past performance records so plain and distinct, enabling a foreman to see at a glance how much he is gaining or losing, you insert the human element. The records*

* The necessary records are illustrated on checking sheet.

should therefore show the number of rivets driven on ground, diameters of rivets (as cost of similar conditions vary by diameters), total cost, and unit costs of this class; also the number of odd rivets and the number of rivets driven on ship, their total and unit costs, the same for a grand total. As a final comparison take the grand total, and from the odd, ground, and ship totals obtain the percentage of each of the grand totals. The high unit cost of odd riveting (due to preparation cost) and the reduction in unit cost for ground work, overhead done on ship, would immediately assert themselves and show that the way to obtain reduced unit cost is by studying conditions and concentrating on reducing the numbers of former and increasing the latter.

The number of rivets on the "checking record" checked off as being driven will give a good idea of the percentage of completion of structural work.

Results of Overhead Distribution

Overhead charges by the production center are useful to compare with actual happenings. The hourly charge of 60 cents is an approximation, but is being worked out. Charges were made against the two jobs illustrated by the percentage plan; by this method results incidental to production cannot be shown. As an illustration, take direct labor, the saving is 38 percent; then take the overhead charges (35 percent of direct labor), again you get 38 percent. Now add direct labor and overhead charges and for the third time you get 38 percent. Under "comparisons," note the results and it will be readily understood that time is more a factor of burden than direct labor.

Low bungling, inefficient labor, dragging out a job, cannot be shown by comparison of overhead charges to be expensive—pay an inefficient man low wages, let him use and abuse your expensive pneumatic hammers and waste power—not as many rivets are driven, but it takes longer to drive them. Comparing low wages and inefficient performers with higher paid, efficient men, direct labor per rivet might be the same, but how about overhead charges? On the percentage plan the charges would appear identical, but the production center method will show the true state of affairs, that the bungler is using two hours of machine time to do one hour's work. This demonstrates that efficient men are economical, even if higher paid, so why not consider them as partners by dividing savings as follows:

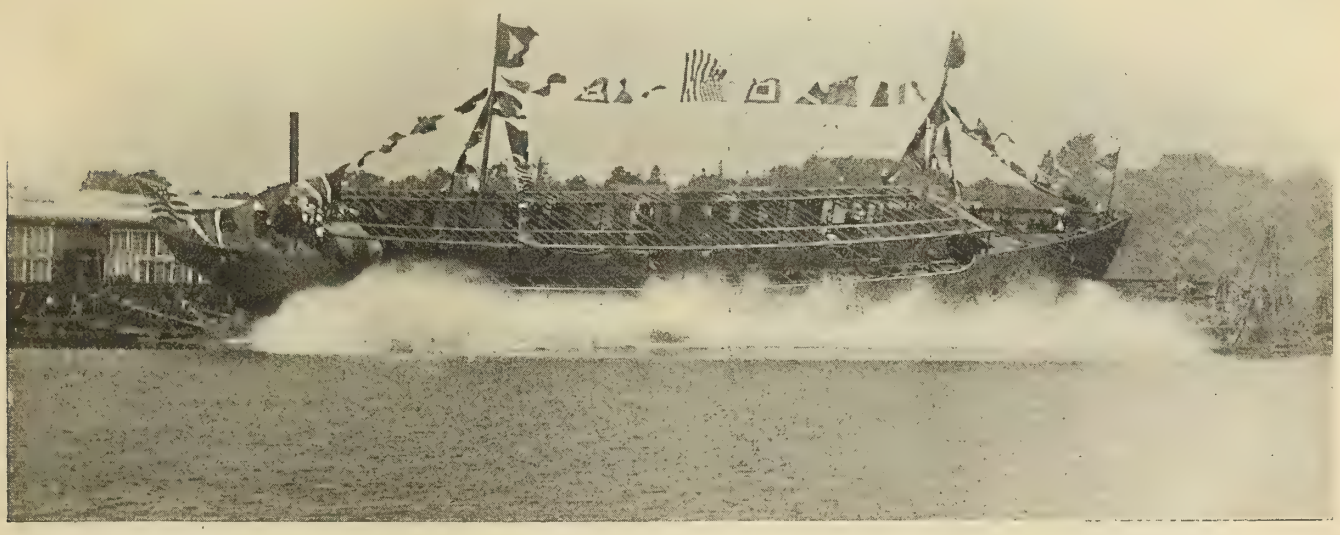
First determine hourly overhead charges on your machines, set tasks by piece work schedule, bonus to begin when day's pay has been equaled, share equally with men the saving in both direct labor and machine time, gangs then get straight piece work price per rivet until reaching 100 percent efficiency; beyond this they share in the machine time saving. Under no circumstances cut wages because men, through skill and effort, increase their earnings. Exorbitant earnings are not possible with the piece work prices in vogue at the different shipyards, but skilled men can and will further increase your dividends and their earnings if assured fair play. When new and improved equipment is installed that will lessen labor and increase outputs, new factors and unit prices must be determined; this should not decrease the men's earnings, although the output is increased.

If a workman by some improvement of his own and at no expense to the company should increase his earnings, wages should not be cut, this discourages improvement; besides, the company is sharing the increased profits.

The fluctuating of overhead charges absorbed by a machine on the percentage plan may be further illustrated by the day work and piece work pay on job in question. Taking 35 percent of labor in each case we get $3.73 charged to piece work and $2.39 to day work. This makes cheap labor appear efficient.

Cost of Hand and Machine-Driven Rivets

When the high hourly charges incident to driving rivets with pneumatic hammers are charged to their proper source and not spread over the works, and low charges incident to hand riveting are charged properly, it would be interesting to know accurately which is the most economical on certain classes of work, particularly oiltight work and watertight work, when the high cost of



Launching the S. S. *Surveyor* at the plant of the Manitowoc Shipbuilding Company

The *Surveyor* is a steel steamer 186 feet long, 34 feet beam and 11 feet 6 inches draft, of 1,000 tons displacement, being built by the Manitowoc Shipbuilding Company, Manitowoc, Wis., for the United States Coast and Geodetic Survey for service in Alaskan waters. The vessel was launched on July 22 and christened by Miss Elizabeth Brent Jones, daughter of Dr. E. Lester Jones, superintendent of the United States Coast and Geodetic Survey.

COALING SEA-GOING VESSELS IN MOBILE HARBOR

Fig. 1.—Maxine Mine Washery

Fig. 2.—Loading Barges at the River Tipple

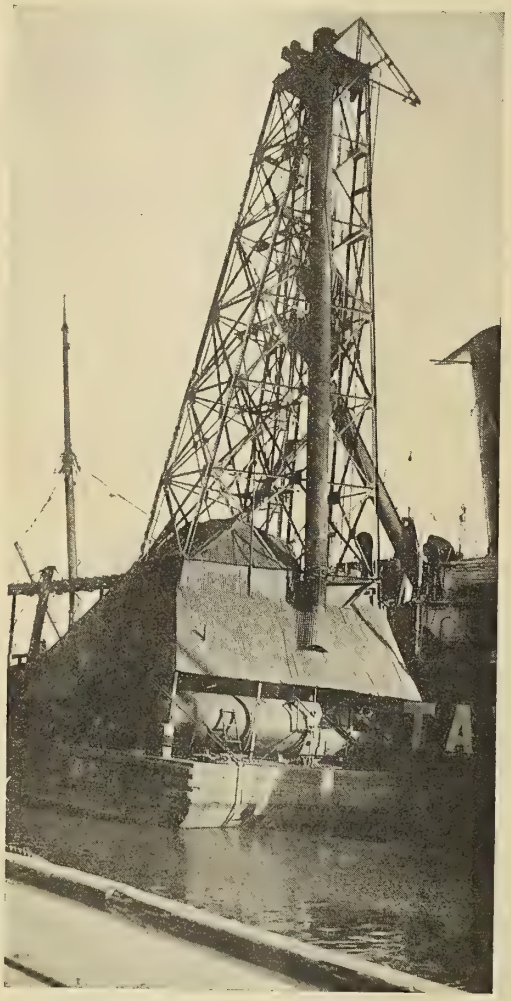
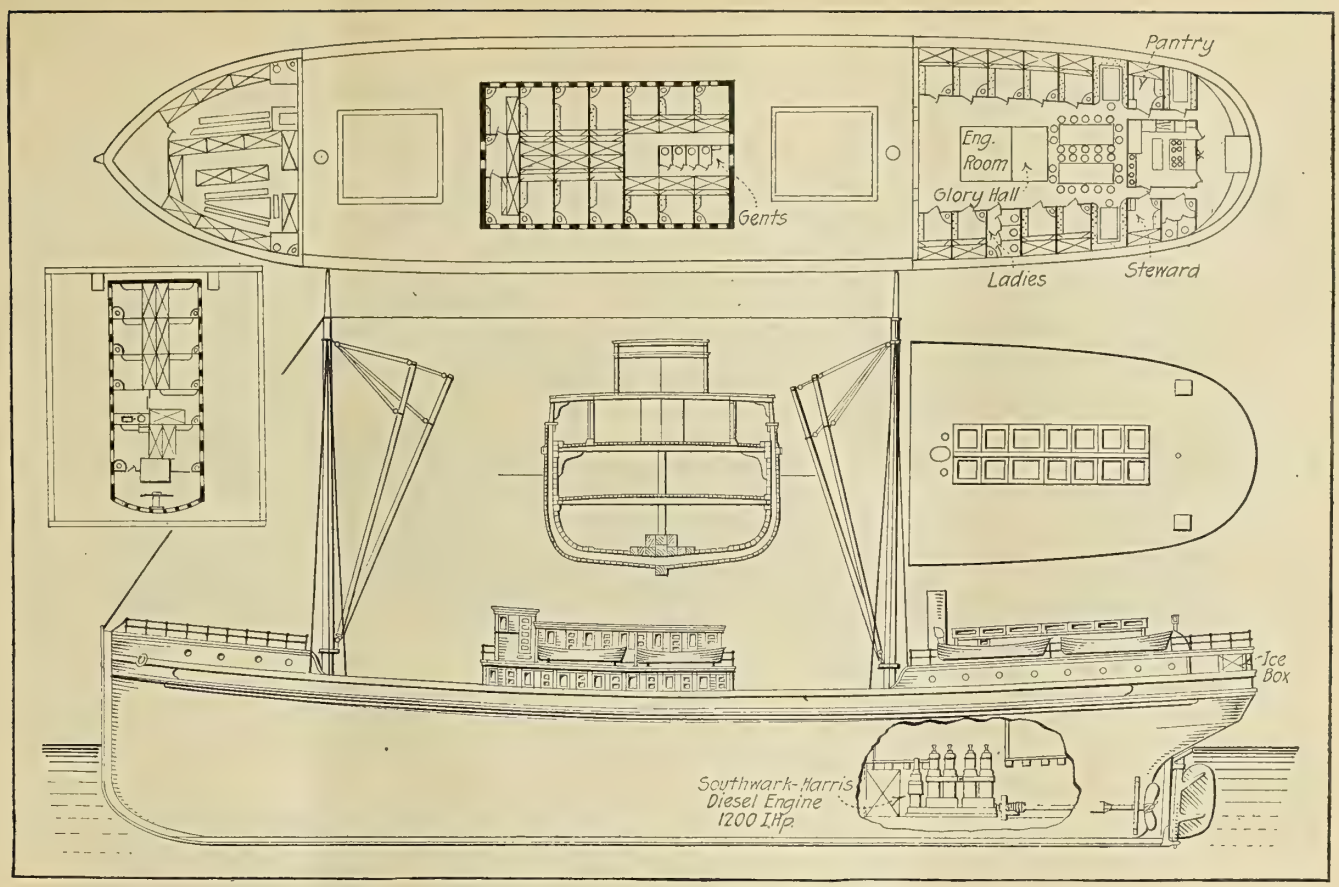


Fig. 4.—Bunkering Vessels at Mobile

Fig. 3—Making Up a Tow at the Tipple

Fig. 5.—Sea-going Coal Barge



General Plans of Large Wooden Motor Ship

tests is considered. It is a known fact that hand rivets draw up and insure tighter work than pneumatic hammer-driven rivets for this particular class of work, which is a very small portion of the rivets in a ship, but a very important part.

Although the writer does not have the facilities at his disposal to solve this, nevertheless the solution would be valuable if someone having the opportunity and means becomes interested enough in "riveting" to work out the results. If all would contribute their mite toward the standardization of operation, beneficial results are likely if not certain to follow every intelligent effort in this direction.

Coal Handling at Mobile, Ala.

The several illustrations on the opposite page show views of the various operations in handling coal at the mines of the Pratt Consolidated Coal Company at Maxine, Ala., and during its transportation to Mobile and its transfer to vessels in Mobile harbor.

Fig. 1 shows the Maxine mine electrically-driven washery where "Little River" coal is prepared for shipment by barge line to Mobile. The river tipple, where the coal is loaded on barges, is shown in Fig. 2. Fig. 3 shows a sternwheel towboat making up a tow at the tipple and Fig. 4 shows the collier *Blossburg* bunkering ships at Mobile. This collier has a capacity of 1,000 tons and will handle the coal at the rate of 150 tons per hour.

In Fig. 5 is shown the sea-going barge *Harry Morse*, which is used for transporting the coal from Mobile to Cuba and other points on the Gulf of Mexico. The Pratt Consolidated Coal Company has two other barges of this type. The barges are towed by the sea-going tug *Asher J. Hudson*.

L. E. G.

Large Motor Ship Building in Seattle

What is said to be the largest wooden motor ship so far built in the United States is under construction at the yards of Nilson & Kelez, Seattle, Wash., for the Alaska-Pacific Navigation Company, of Seattle. The vessel is 232 feet long, 42 feet beam, 23 feet molded depth, with a load draft of about 18 feet, and was designed by Mr. R. M. Semmes, vice-president of the Alaska-Pacific Navigation Company. She will be propelled by two 625 indicated horsepower Southwark-Harris heavy oil engines, manufactured by the Southwark Foundry & Machine Company, of Philadelphia.

The boat is designed for a speed of about 11 knots and will be used for lumber carrying and general cargo and passenger services. She will have a freight capacity of 1,800 tons deadweight, and, owing to the small space required for the propelling machinery, will be able to handle 1,500,000 feet of lumber. Cargo will be handled through two hatches, each of which is equipped with two 6-inch by 9-inch Heffernan winches, supplied with steam by an auxiliary steam plant which will also provide steam for heating and for the electric plant.

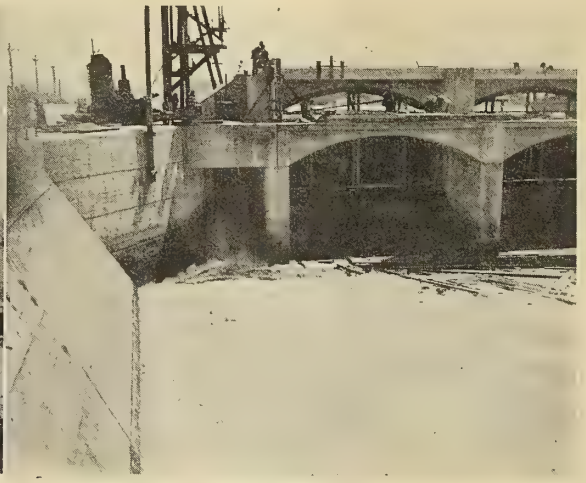
Memorial to Sir William White.—At the Institution of Civil Engineers, London, on July 26, Admiral Sir Reginald Custance formally presented to the Council of the Institution a medallion portrait of the late Sir William White, which has been provided out of a fund collected from all parts of the world to commemorate the work of the late naval constructor. The medallion bears two inscriptions. Above the portrait of Sir William are the words, "Build Staunch and True," while beneath the portrait is the following: "Sir William Henry White, K. C. B., LL. D., D. Sc., F. R. S., President 1903-4, Director of Naval Construction, 1885-1902. A tribute from the shipbuilders and engineers of many nations."

LAKE WASHINGTON CANAL AT SEATTLE, WASH.

Power Station

Lock Superintendent's House

The Spillway (Salt Water Drain at the Left and Fish Ladder at the Right)



Mouth of Salt Water Drain and Portion of Spillway

Large Locks Filled. To the Left Is Entrance to Auxiliary Lock

Official Opening of the Canal. S. S. *Swinomish* Passing Through the Locks

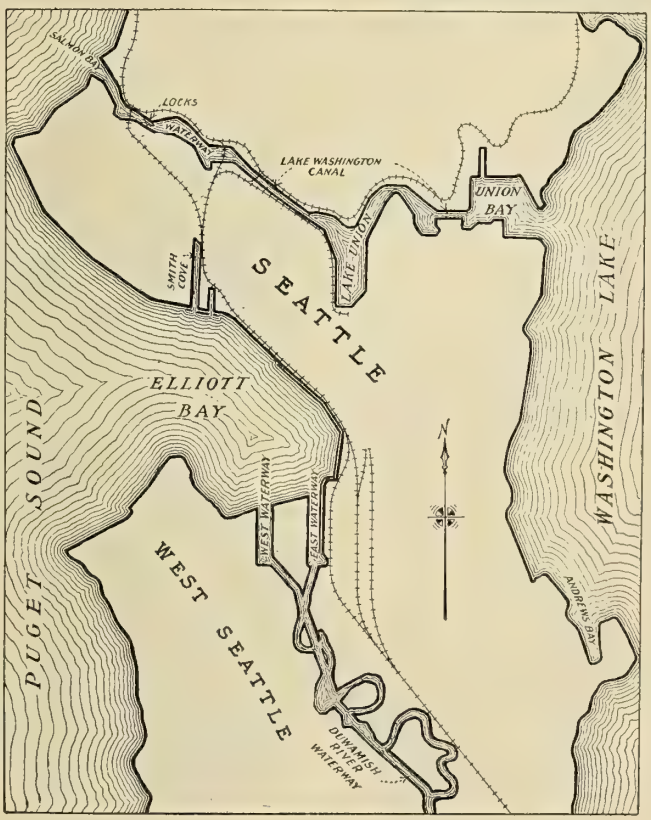
Completion of Lake Washington Canal

Opening of the Canal Makes Over Sixty Miles of Additional Water Frontage Available to Seattle's Shipping and Shipbuilding Industries

BY GILBERT C. DOHM *

WITH the formal opening of the first unit of the Lake Washington Canal on August 2, 1916, Seattle, Wash., now has prospects of some day becoming the New York of the Pacific Coast and the terminus of most of the Pacific Ocean's steamship travel. On July 30 the auxiliary lock leading to the canal was opened and the steamer *F. G. Reeve* made the first passage through the lock. August 2, however, was the gala day, when the United States Corps of Engineers' boat *Swinomish,* accompanied by the cruiser *Orcas,* passed through the main lock and officially opened it to all ships and for commercial use.

* The writer of this article is indebted to Mr. C. A. D. Young, assistant engineer and designer of the gates and machinery for the lock, for much of the information contained herein.



Map Showing Location of Lake Washington Canal

Increase of Commercial Waterfront

The former natural shore front of Seattle on Elliott Bay, available for use in the shipping and manufacturing industries, amounted to about 4½ miles, compared to the 45 miles of New York's first-class frontage. The rest of the territory bordering along Elliott Bay and adjacent to Seattle is either filled in or is hilly and precipitous, and the expense involved in the removal of such natural formations without the subsequent gain of much territory did not warrant this undertaking. With the opening of the canal, however, some 60 miles or more of extra waterfront territory is made available to shipping interests, while 12 miles of that portion is already of a flat and desirable nature and has the advantage of railroad transportation and

cheap electrical power. The opening of such a vast territory will give to Seattle the permanent asset of having an area available for manufacture greater than any city in the United States.

Aside from the added advantage of increasing the commercial water frontage is the prospect of maintaining the largest fresh water basin in this country where ships for ocean travel can anchor or load and at the same time free their underwater bodies of sea growths to some extent, without the actual cost of drydocking. Whether or not

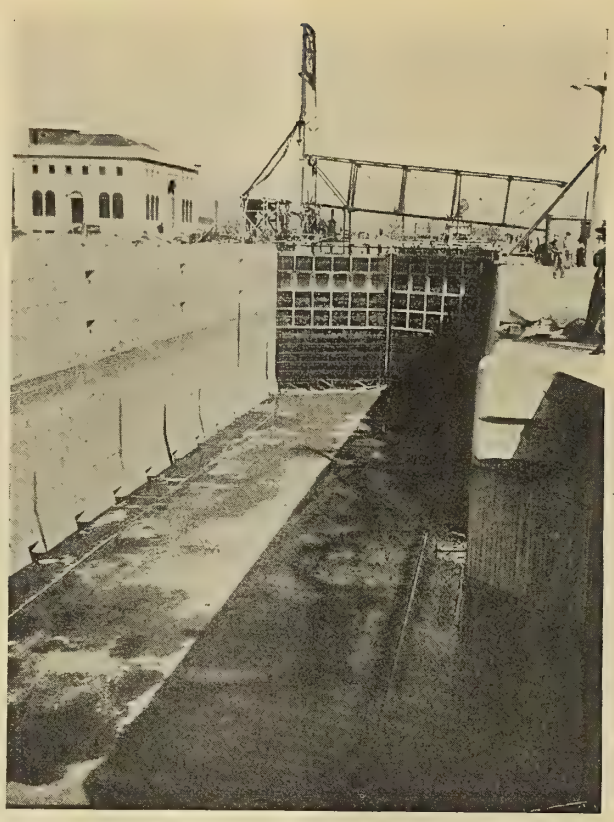
Auxiliary Lock—Gates Closing

Lake Washington and Lake Union, which are connected, will remain fresh water, is a topic of some discussion, as the method of draining off the salt water seepage from the Sound is purely experimental. Should this be the case, however, combined with the economies of a constant water level basin, with no variation due to tide, this is a factor not to be overlooked.

Elliott Bay, while possessing many advantages as a protected harbor, has one great disadvantage in the extreme depth of its water and the consequent difficulty found in anchoring. The Lake Washington Canal will to some extent eliminate this difficulty in the case of ships intending to anchor for some time, by opening up these two fresh water basins with their first-class anchorage facilities.

Eliminating Flooded Areas

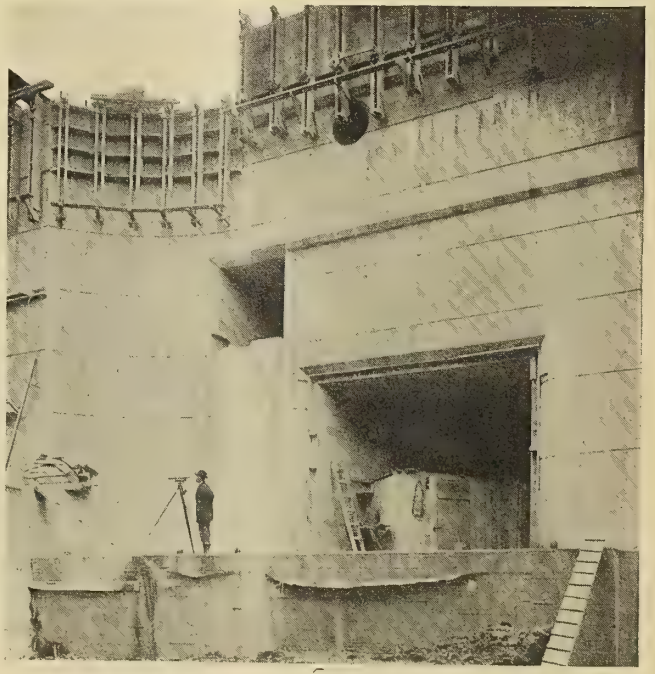
In the lower Lake Washington region floods have been prevalent, due to the swollen conditions of the Duwamish River. As the level of Lake Washington will be decreased from 8 to 9 feet, the Cedar River, which now empties into the Duwamish and Black rivers, will change its course and empty into Lake Washington, reducing the volume of the Duwamish River some twenty-five percent, thereby eliminating to a great extent the cause of these flooded conditions. This decrease in the level of Lake Washington will also tend to drain off many of the swampy districts, thus converting such territory into high and dry ground.



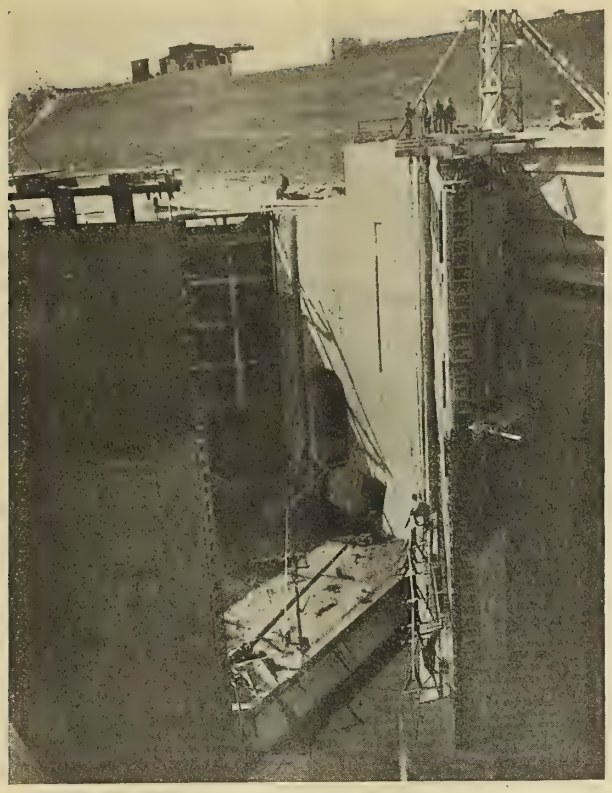
Large Lock Empty. Mid-Length Gates in Background

Portion of Salmon Bay Made a Fresh Water Basin

The canal locks are located about midway up Salmon Bay. When the canal connecting Lake Union with Salmon Bay was opened, that portion of Salmon Bay above the locks became a fresh water basin and assumed the same level as Lake Union. At high tide the difference in the water level between the lower end of Salmon Bay and that portion above the locks is about 8 feet. Upon completion of the canal connecting Lake Washington with Lake Union, the level of the water in Lake Washington will lower itself about 8 or 9 feet and assume the level of Lake Union.



Upper End of Large Lock, Showing Filling Culvert



Gates of Large Lock Open. Inside Are Guard Gates and Culvert for Filling

Locks Among the Largest of Their Kind

The canal locks are two in number and side by side. The larger one, which is 825 feet long by 80 feet wide and 55 feet deep, opens into a channel 36 feet deep at the Puget Sound end. It is fitted with a set of operating gates weighing about 230 tons apiece, at either end and at mid-length. The mid-length gates are used when ships under 375 feet long, but too long for the auxiliary locks, pass through. The machinery, which is all electrically operated from stations along the lock, is housed in the walls of the lock, which are about 55 feet thick at the bottom and 8 feet thick at the top.

Provision has also been made for using the lock in case of necessity for a dry dock, by fitting at either end a guard gate which opens outward. Two 30-inch pumps are used to empty the lock, the time consumed being about eight hours.

The auxiliary lock, capable of taking boats up to 16 feet draft, is 130 feet long and 30 feet wide.

Both locks are filled with water from Lake Union and emptied into the lower end of Salmon Bay by the gravity system through culverts in the bottom of the side walls, the culverts having openings at constant intervals which lead into the lock. No pumps are therefore required to fill or empty the lock. In the large lock the operation of filling and emptying requires from five to eight minutes, according to the height of the tide.

Looking Down Inside the Fish Ladder. In the Lower Right-Hand Corner Is the Entrance in the Dividing Wall. At the End of the Ladder Is the Entrance into Salmon Bay.

Lock Empty, wth Gates Open

In order to operate the locks at night, a series of high-powered lights stationed along the wall furnish the necessary illumination.

Abreast the locks lies the spillway, salt water drain and fish ladder. The spillway is about 150 feet wide and 30 feet deep. It will carry off all the overflow of Lake Washington and Lake Union and is provided with a gate to maintain a uniform flow for use in the generation of electrical energy.

Salt Water Drain

It was found that in the Panama Canal the salt water worked its way along to the fresh water lakes, killing the fish and ultimately changing the lakes to salt water basins. In order to eliminate this in the Lake Washington Canal, a large sump was built at the inner end of the locks. The salt water being heavier than the fresh water, will stay at the bottom and pass into this sump on

its way to the lakes. From the sump it will drain out through a tunnel which empties into Salmon Bay. The mouth of the tunnel is at all times higher than the high water level in Salmon Bay but lower than the level in Lake Union. Tests on water secured at the bottom of Lake Union after this method was in operation showed no trace of salt water, which leads to the belief that Lake Washington and Lake Union will always remain fresh water basins.

Fish Ladder

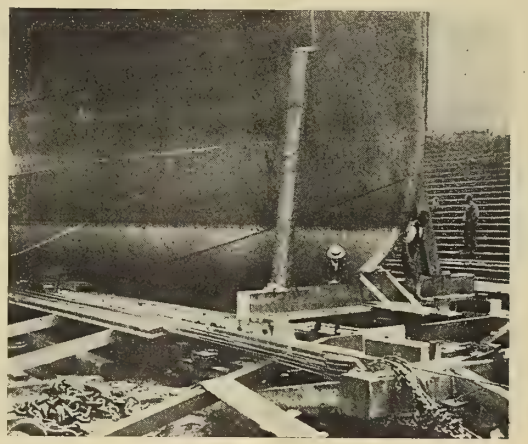
A unique feature of a portion of the locks is the provision made for allowing the fish to pass up beyond the spillway. For this purpose a so-called "fish ladder" was built. This consists of two concrete walls running parallel and in the same direction as the locks. The enclosure between these walls is divided into sections by another series of walls built in transversely and a little oblique to the first pair. In these dividing walls are cut entrances about 18 inches square, through which the fish pass, the entrance to each consecutive apartment being somewhat higher than the previous one, thereby gradually leading the fish up to the water on the other side of the spillway. Water is continually flowing from above the spillway into the ladder and through the entrances into Salmon Bay, but on account of the subdivisions in the ladder the initial head of the water is also divided and the consequent flow is not sufficient to hinder the fish. The ladder is open on the top to admit air and sunlight.

The work of building the canal was started in 1911, having been the source of much controversy and debate. The total project will cost in the neighborhood of $5,000,000 (£1,025,000). Seven hundred and fifty thousand dollars (£154,000) was appropriated by King County, in the State of Washington, and $250,000 (£51,000) by the State of Washington, the remainder being appropriated by the Government. The work is all of concrete and the locks are among the largest of their kind.

Cargo Steamer Lengthened Over 50 Feet and Converted Into an Oil Tanker

One of the liveliest pieces of ship repair work ever accomplished in a modern ship repair yard was carried out in the first two weeks of July by the Robins Dry Dock & Repair Company, Erie Basin, New York, in lengthening by about 52 feet the cargo steamer *George E. Warren,* a single deck steel ship of 2,306 gross tons, 246 feet 6 inches long by 43 feet 9 inches beam by 25 feet 3 inches depth. The vessel was built at a Toledo shipyard four years ago for the Atlantic Coast Gulf trade and is owned by the Boston-Virginia Transportation Company, New York. Recently the vessel was chartered for a long period for the transportation of oil in bulk, and it was decided to lengthen the hull by about 52 feet in order to increase the carrying capacity by about 1,000 tons. It was also necessary to convert the ship into an oil tanker by the installation of oil-tight bulkheads and oil-pumping arrangements.

The vessel reached the Robins dry dock on July 2 at 11 A. M., and by 4 P. M. the next day she had been cut

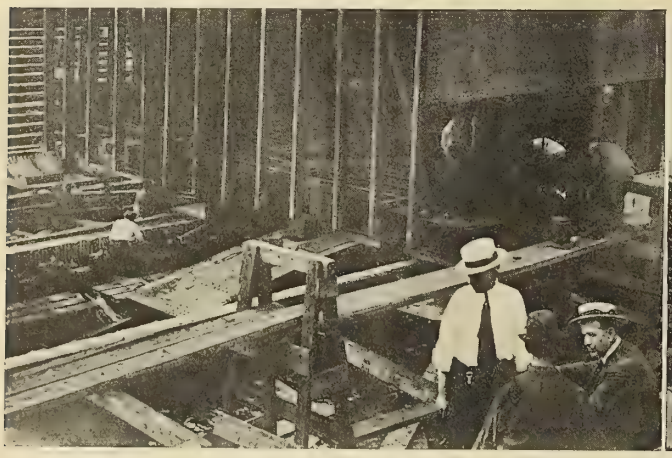


Tackle for Moving the Forward Section

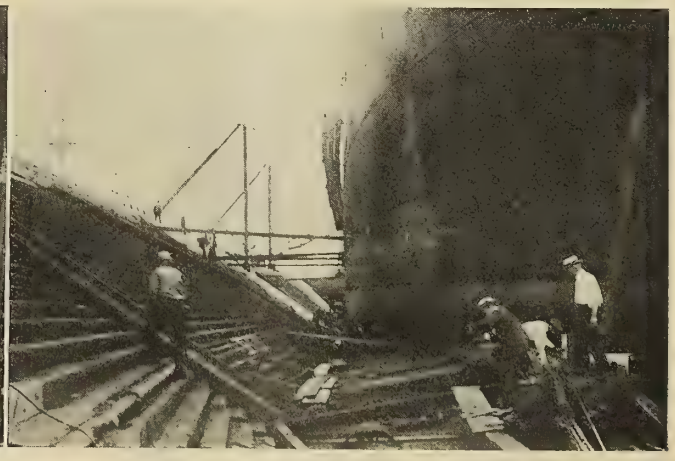
in two and pulled apart 52 feet and was ready to receive the new framing, flooring and plating. The actual time required to pull the two parts of the vessel apart was only 11 minutes.

This was accomplished by building on the bottom of the dry dock ground ways on which were built sliding ways for the forward section of the boat. The sections were hauled apart by means of block tackles and special winches, and any irregularities in the alinement of the sections was corrected by means of shoring and wedging.

That this work could be completed in the short space of about two weeks speaks well for the ingenuity and skill of the men who had the work in charge. The Robins Dry Dock & Repair Company, however, is accustomed to handle work of this character and the unusual facilities afforded at that plant make it possible to eclipse all records in the rapidity of such operations.

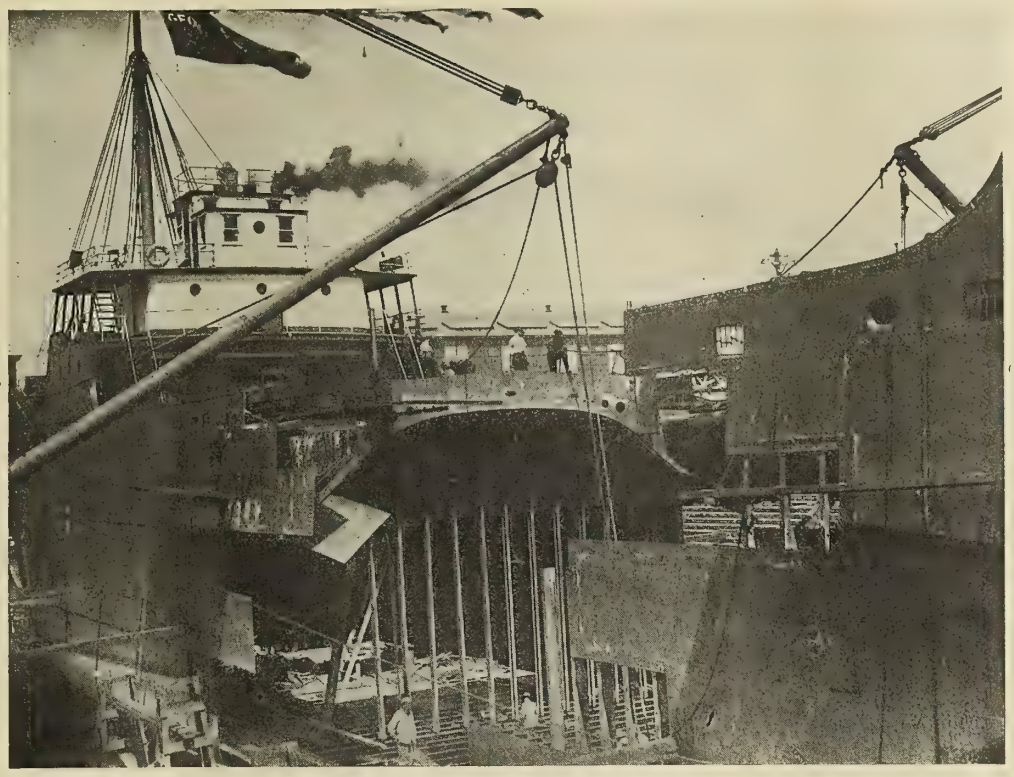


Preparing to Frame the New Section

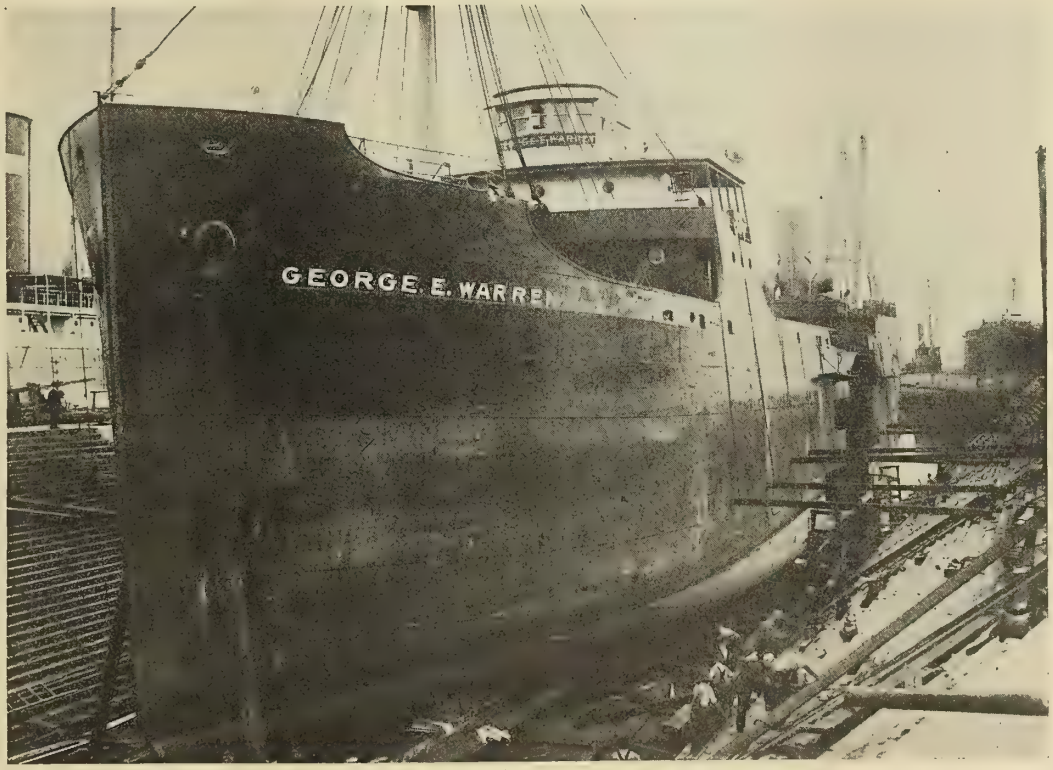


Rigging the Moving Tackle in Dry Dock

LENGTHENING AND REMODELING THE GEORGE E. WARREN



Building the New Section Amidships



S. S. *George E. Warren* in Dry Dock for Lengthening

Former Pacific Mail Steel Steamer S. S. *City of Sydney*, Converted into a Six-Masted Brigantine by Moore & Scott Iron Works, Oakland, Cal. Length, 339 Feet; Beam, 40 Feet; Depth, 20.5 Feet

New Plate and Angle Heating Furnaces Installed at the Cramp's Shipbuilding Plant

Among the recent improvements made in the extensive plant of the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., is the installation of three large plate and angle heating furnaces furnished by the Metals Production Equipment Company, New York.

This new equipment includes one plate heating furnace with a heating chamber 9 feet wide and 36 feet long, and two angle heating furnaces, one with a heating chamber 30 inches wide and 81 feet long, and the other with a heating chamber 30 inches wide and 51 feet long. These furnaces all use oil for fuel in connection with air compressed at a pressure of about 10 to 12 ounces.

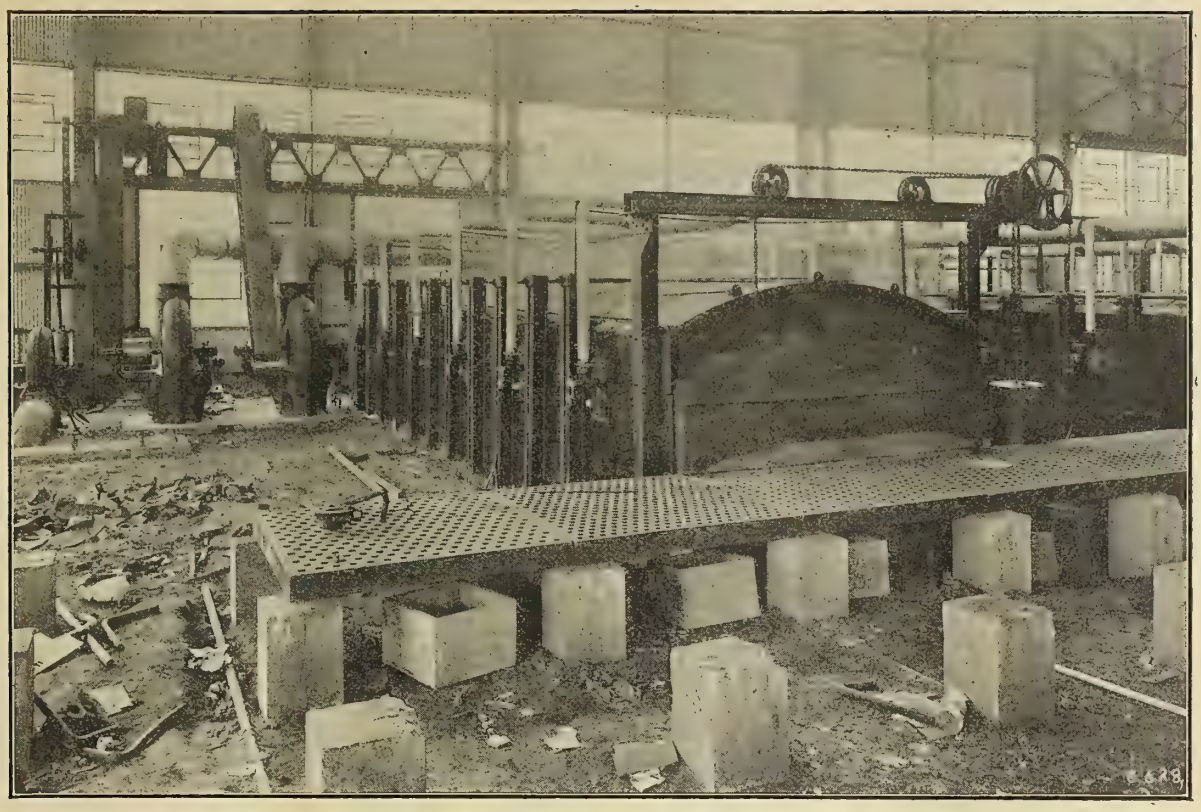
The oil is supplied by rotary pumps at about 25 pounds per square inch pressure, and the air is supplied by Sturtevant steel fan pressure blowers. Both the oil pumps and blowers are installed in duplicate to insure against a shutdown of the furnaces in case of accident. All of the furnaces have doors at one end only, the door opening in the plate heating furnace being only 22½ inches high in the clear, while the door openings in the angle heating furnaces are 25 inches high.

As can be seen from the illustrations, the oil burners are located on both sides of the furnaces and near the top of the heating chamber. The spent gas flues are in each side wall near the hearth level and pass under the hearth and up through each side wall to the atmosphere. The outlet of each flue is provided with a separate damper. With this construction it is possible to obtain a uniform heating condition in the working chamber, a hot hearth and a close control of heat circulation. By the proper use of the dampers, the heating chamber can be kept under pressure, which excludes excess oxygen and reduces scaling effect.

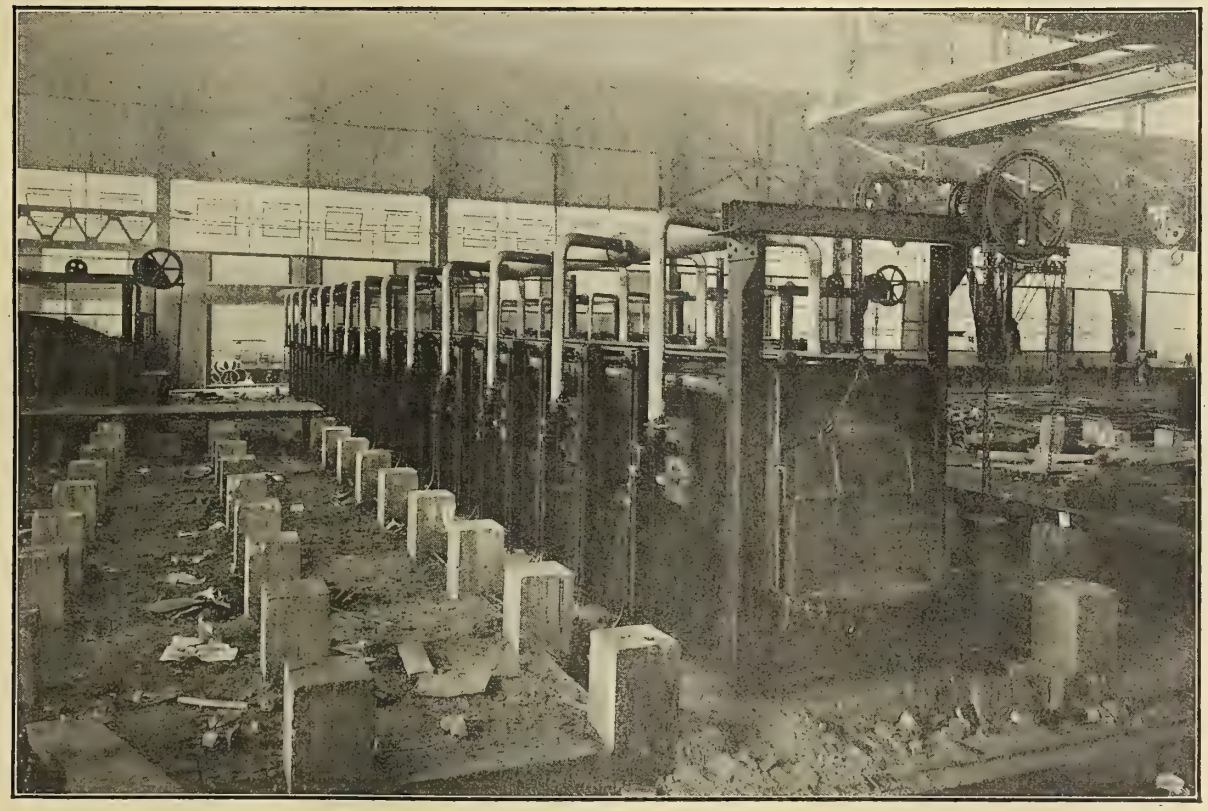
This arrangement of introducing the heat and controlling its escape makes it possible to carry different temperatures in different parts of the heating chamber or to heat only one part at a time if necessary, thus making it possible, as is frequently necessary in shipyard work, to heat the center or end of a long bar for flanging or bending operations without bringing the entire chamber up to the required heat.

For the economical operation of these furnaces, great care has been taken to reduce the loss of heat by radiation to a minimum. The best quality of fire brick is used in the walls and arches, and, in addition, a layer of special insulating brick is placed outside, forming a very effective heat-insulating medium.

The fronts of the furnaces are built of heavy cast iron and slightly inclined, so that the door is always in close contact with the front plates, thus preventing the escape of heat around the door. The doors are made in upper and lower sections, so that the lower section can be renewed when burned, without the expense of an entirely new door. Below each door a steel roller is provided to



New Plate Heating Furnace at Cramp's Shipyard



One of the Angle Heating Furnaces

facilitate the handling of material. The floors of the heating chambers are made of heavy hard-burned slabs, laid independent of the side walls to permit easy and quick renewal.

The furnaces are entirely encased in steel plates, so that no brickwork is exposed, and they are supported by I-beam buckstays, securely tied together with steel binding rods. The construction of the foundations for the bending slabs and the arrangement of the blower fans are clearly shown in the photographs on this page.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Comparison Between Pneumatic and Electric Portable Drills and Geared Hoists

Both pneumatic and electric portable drills are commonly used in shipbuilding, but owing to the fact that the initial costs of pneumatic and electric drills of the same power are about the same, the principal items for comparison in their operation are as follows: power consumption, durability, utility.

Portable Drills

For pneumatic drills the power consumption will be taken as the portion of the power of the motor driving the air compressor necessary for compressing to the required working pressure each minute the quantity of free air necessary to drive the drill under load. For electric drills the power consumption will be taken as the horsepower developed by the motor driving the drill under load.

The following table gives comparative results of three sizes of pneumatic and electric drills:

Maximum diameter of the hole drilled in mild steel plate	9/16	⅞	1¼
Revolutions of the drill per minute	500	300	200
Free air consumed per minute for pneumatic drill (with motor of four single acting cylinders), 90 pounds per square inch pressure, cubic feet	25	35	53
Consumption of power of the motor driving the compressor, for compressing to 90 pounds pressure the quantity of free air quoted above, horsepower	4.7	6.7	10
Power developed by the small motor driving the electroc drill working as above stated, horsepower	0.75	1.25	2
Proportion of power required for pneumatic drill in comparison with electric drill of the same drilling capacity	6.3:1	5.4:1	5:1

As far as the power consumption is concerned, it is found that pneumatic drills consume about five and a half times the power required for corresponding electric drills.

In regard to durability, it will be found that the electric drills are not as strong as the pneumatic drills, and frequently a workman using an electric drill will either by using it in an improper position, or else by forcing it beyond the limit of its capacity, burn out the motor and render the drill useless. On the other hand, if pneumatic drills are overloaded, they will stop without damage. Moreover, as nearly all of the electric drills used in shipyards have ventilated motors, due to the fact that a closed motor would be too heavy, the motors are easily damaged in damp weather by corrosion caused by the salt in the sea air circulating in the motor.

In the case of pneumatic drills there is little likelihood of serious damage to the flexible connection from the source of power to the drill. If there is slight damage to the flexible hose pipe conveying the compressed air to the drill, there will be simply a slight loss of air without other inconveniences. On the other hand, with electric drills, if the insulating cover of the wire conveying the electric energy to the drill is damaged by friction on the edges of steel plates, or from other cause, dangerous short circuits will result with possible damage to the workmen and the work.

Geared Hoists

In comparing pneumatic geared hoists with the electric hoists, disregarding the pneumatic direct-acting piston hoists owing to their excessive weight, it will be found, as in the case of drills, that the pneumatic hoists will consume more power than electric hoists of the same capacity and hoisting speed. Moreover, the pneumatic hoists at present available on the market cannot after a few weeks' service at maximum capacity maintain the load at a fixed height, the leakage causing the load gradually to descend, with the result that the hoist must be repaired and put in first class condition again.

On the other hand, electric hoists have none of these disadvantages, nor any of the others attributed to electric drills, so that, as a rule, electric hoists are preferable to pneumatic hoists in shipbuilding work.

Electric hoists are rarely overloaded, as the capacity of the hoist is usually rated considerably above the average load to be handled. They are also fitted on jibs or overhead traveling cranes, or on fixed beams at a considerable height above the ground or floor, so that the wires conveying the electric energy to the hoists are very unlikely to be damaged by contact with the material raised or with the supports. Electric hoists have the added advantage that they can be fitted with closed motors giving good protection from the effects of the sea air.

Conclusions

From the above it may be concluded that in shipyard practice pneumatic drills, although requiring more power, are preferable to electric drills because they are less easily damaged when overloaded or roughly handled, and because serious damage cannot result from injury to the flexible connections transmitting the power to the drills, as in the case of wires supplying the electric drills.

On the contrary, in the case of geared hoists, it will be found that electric hoists are preferable because they consume about one-fifth of the power required for pneumatic hoists, and, furthermore, they are easier to maintain and are more reliable.

Genoa, Italy. Adolfo Bassi.

Renewing Wornout Pump Linings

When pump linings become worn out, badly scored or deteriorated, new liners are almost always obtainable from the makers of the pump. Giving them the data of the pump, generally the serial number is sufficient. Some pumps have a spare liner on hand at the time of their installation. This is the best practice, for a spare furnished at the time of installation of the pump is generally a counterpart of the one in the pump and made by the same workmen. These hardly ever give any trouble fitting them, whereas one ordered some years later may have a small error in measurements and give a little trouble when it is installed.

Original liners that are placed in the pump by the makers are almost sure to be forced in by hydraulic pressure, therefore it is most likely that when it is to be taken out the quickest and easiest method will be to cut it out with a long diamond point or round nose chisel, although

the same method used in putting them in can be tried for taking them out if desired.

The following is the method used in our plant for renewing liners: After removing the old liner, the inside of the pump barrel is callipered and the measurements of this and the new liner checked up to see if any draw filing is necessary to enter the liner and that it is not too large for drawing in. A table of allowances for force and driving fits is given in "Kent's Mechanical Engineer's Pocket Book." For force fits to a 10-inch cylinder .010 is allowed, and for each one inch of increase in diameter of liner a little less than one-thousandth for forcing is allowed. For a 20-inch diameter there is allowed .017. Now, a *drive* fit is only one-half a forced fit.

The entering end of the liner is slightly chamfered to aid in easy starting. Then the outside of the liner is given a coat of grease, also the inside of the pump barrel. The

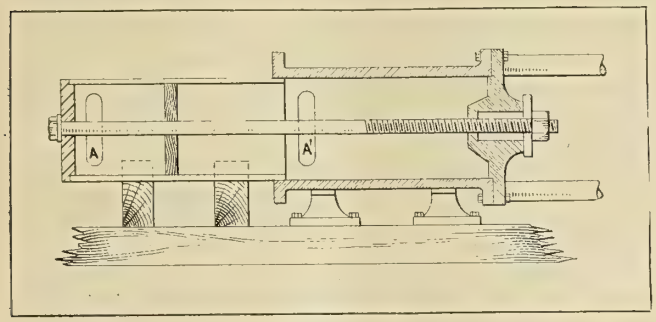


Fig. 1

liner is then placed in position as shown in Fig. 1 and entered as much as possible by hand.

There should be two blocks of wood sawed out half-circular to the outside diameter of the liner and of just the correct height to support the weight of the liner in line with the cylinder bore as shown. A circular piece of plank is cut to fit the inside of the liner, with a hole just the diameter of the long rod or bolt. This supports the weight of the rod.

A circular plate has to be made from heavy boiler plate to the sketch as shown, having a projection on the inside of the liner and just slightly smaller on its outside diameter than the liner, with a hole in the center for the rod. The bolt must be long enough to project through the stuffing box, and a heavy plate washer used under it as shown.

Now by screwing up on the nut the liner can be drawn home. A wrench must be used with long leverage, and one at the other end to prevent turning the rod. When starting the liner into the cylinder care must be taken, if there are any ports, to see that they are going to line up as *A* and *A'* in the sketch.

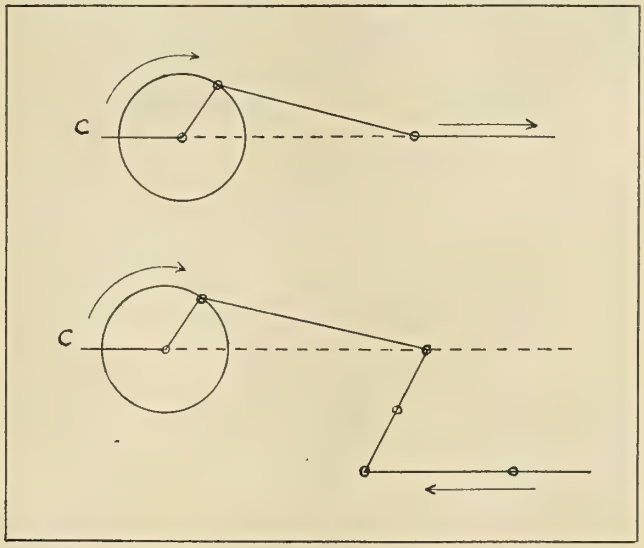
The diameter of the long rod or bolt should be the same diameter as the piston rod used on the pump. This just fits nicely in the stuffing box. It could be made in two parts with a coupling, using one section of piston rod and making the long, threaded part of a separate piece.

C. H. W.

New Giant Liner Ready.—The British Admiralty has handed over the steamship *Statendam,* which was purchased on the slips at Belfast from the Holland-America Line shortly after the beginning of the war, to the Cunard Steamship Company. She is being fitted out to carry freight between New York and Liverpool, and will be called the *Neuretania.* Cunard officials in Liverpool say the new steamship will have cargo space for 21,000 tons, the largest amount of freight ever shipped from America on a single vessel.

Direct and Indirect Valves

There appeared in the August number of Marine Engineering an inquiry pertaining to direct and indirect valves, and the explanation given, while generally accepted, is not in my opinion correct, for I hold that a direct valve may be either outside or inside, and likewise an indirect valve may be either outside or inside, depending upon the manner in which it is connected. For instance, where the valve stem is direct connected to the



Upper Diagram, Direct-Acting Valve; Lower Diagram, Indirect-Acting Valve

eccentric rod and is therefore under the direct influence of the eccentric and rod, the valve is said to be *"direct,"* but where the valve stem is worked through a *rocker arm* it is said to be *"indirect,"* as the accompanying sketch will show.

These arrangements give four combinations, as shown in the following table:

Valve	Connection	Angle Between Crank and Eccentric	Which Leads
Outside	Direct	$90 + \delta$	Eccentric Leads
Inside	Direct	$90 - \delta$	Crank leads
Outside	Rocker	$90 - \delta$	Crank Lead
Inside	Rocker	$90 + \delta$	Eccentric Leads

U. S. S. *New York.* James Kirvan, C. M. M.

Dredge Troubles

Some time ago the writer had occasion to visit a dredge that was operating in a fresh water river. The owner, a friend, stated that the output of the dredge was being handicapped by reason of the boiler priming constantly at heavy loads, and that he was positive that the priming was not due to the boiler being dirty, as it had been given a thorough overhaul during the previous month. To understand the case better, a description of the situation is necessary. The dredge was laying in a bight of the river, and the water, while dirty, was fresh. It was secured by the usual lines, and was free to rise and fall with the tide, with plenty of water under the bottom, a point which is well to note when securing a dredge. The silt for the suction was supplied by barges and the discharge lines were normal, so everything was quite usual. The boiler, of the Heine type, was situated in the after end of the dredge. The engine was set about twenty feet forward of the rear end of the boiler, thus giving a very short lead for the steam piping. Also it was noted that the engine throttle was on the same level, horizontal, as the top of the steam drum. Water was supplied to the

boiler by an injector, but the feed heater installed was not in use.

Having ascertained these points, I questioned the man who was in charge of the plant. From what information he was willing to supply, it was quite evident that the above-mentioned boiler trouble was chronic. Moreover, he stated that when the feed heater was in use the injector gave trouble, hence he did not use the heater.

One point was evident at once, the boiler was being handicapped, but this was not incidental to priming, and it may be added here that the Heine boiler is not subject to this disease if properly handled. The feed water, while not being such as any self-respecting boiler would receive of its own volition, was not so bad as to cause excessive priming at the rate of steaming demanded of the boiler. Examination showed that the strainer was of the old-fashioned basket type and sadly in need of cleaning. A modern strainer with periodic cleanings was recommended for this. The injector trouble was simply a combination of the strainer conditions and having the feed water too hot. Nearly every engineer knows, or at least should know, that the temperature of the feed water radically affects the action of an injector, and that a set of curves should be obtained with the injector, either from the builder or elsewhere, one of these curves having been obtained by making a series of runs with steam and discharge pressures adjusted as for ordinary operation, average lift and suction, and varying the temperature of the suction water, starting at a low temperature and gradually increasing the temperature of the suction water until the injector "breaks"—refuses to operate. In the case under observation it was very evident that this knowledge was lacking on the part of the man in charge, and that his feed water was too hot. So all that was needed here was a little adjustment of the feed heater.

Having mentioned these, let us say, minor troubles, we will return to the main cause of contention—the excessive priming of the boiler. From the facts so far ascertained, it was quite evident that the trouble was either in the steam piping or in the setting of the boiler itself. The water in the boiler was being carried at a normal level, about one and one-half gages at the time and everything was going satisfactorily. For a time the proposition looked like a real problem, but a short conversation with the fireman brought to light the fact that at high rates of steaming he considered it essential to safety to carry at least a half glass of water. Other things being equal, this should not have caused such havoc, but it did give a hunch, and that hunch was to examine the setting of the boiler as regards the height of the front of the drums relative to the height of the rear.

There was nothing more to it. A few measurements showed that the rear end of the drums was some inches below normal position. This was caused by improper lining up in the original installation or by a drop in the foundation, the latter being the most probable. However, such was the case, and should have been discovered when the dredge was purchased. It was now too late to rectify it except at excessive cost, as the dredge was working on contract. The substance of the case was that the dredge was a bad bargain. However, the case was not entirely hopeless, as will be seen later.

To understand the effect that the setting had on the priming it is first necessary to consider how moisture gets into the steam. Consider a bubble of steam rising up through the water, when it reaches the surface it must break through the surface film. As the surface tension is overcome there is a small explosion and the film is shattered, with the result that minute particles of water are scattered in all directions. These minute particles are picked up by the outflowing steam current and carried along into the steam pipe. It is quite evident that the greater the amount of steam generated, the greater the number of explosions, hence at high capacities there will be more minute particles of water being scattered in all directions. Furthermore, if the disengaging area be in any way reduced, the agitation will increase and at the same time the exit velocity of the escaping steam will increase. Hence it is proper to assume that a greater amount of moisture will be picked up and carried into the steam line by the outrushing steam. In other words, the amount of moisture entailed will depend on two things: first, the cubic feet of steam escaping; second, the area of the surface through which it escapes; the one divided by the other giving the mean exit velocity.

In the case of the boiler in question it was safe to assume the velocity of the water circulating in the tubes to be about sixty feet per minute and the cross-sectional area of the tubes to be about seven square feet. That is, in one second there would be discharged to the water leg seven cubic feet of water. Now if the area of the water passage from the leg to the drum is two square feet, the velocity will be in the vicinity of three feet per second. And considering that this water is now in the form of steam, it is safe to assume the velocity to be nearly doubled, with the result that the water level may be lifted several inches. Naturally there will be a violent surface agitation with a big percentage of moisture kicked up, more or less of which is bound to be picked up by the outflowing steam.

If the above conditions exist normally, what must be the conditions when the disengaging area is reduced by one-half or one-third? Such, however, was the case here. When the water glass showed half full, the water was close up to the top of the drum in the rear and the designed steam space and disengaging area were reduced by fully thirty percent, the result being that a great amount of moisture was whirled upward into the short steam line take-off and from there led directly to the engine throttle. To change the setting, as mentioned before, was out of the question. But it was possible to make four improvements: first, feed cleaner water; second, feed hot water to the boiler; third, carry the water at a lower level in the boiler; fourth, make a simple change in the discharge steam piping, this latter being in the form of a small steam drum to counteract the reduced steam space in the drums proper. The discharge pipes from the drums were very short and connected by a pipe of nearly the same diameter. As can be seen, the idea was to increase the length and the diameter of this pipe so that it would have a fairly large capacity, and thus allow time for the entailed moisture to be thrown down. From latest reports everything has been going satisfactorily.

Having never before had the opportunity to visit a dredge, the situation was much more interesting than it would have been otherwise, and it is believed that the points brought out above will be of interest to anyone in the dredge business, as they are general in nature, and it seems to me quite likely to be prevalent, owing to the peculiar conditions under which dredges are operated.

D.

LAKE SEAMEN'S WAGES RAISED.—At a meeting of the board of directors of the Lake Carriers' Association in Cleveland, August 3, all Lake seamen below licensed officers were granted a raise of $10 per month in wages for the period from August 1 to October 1. The directors recommended that the question of additional remuneration for licensed officers be taken up at a later meeting of the vessel owners.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Marine Reduction Gears

Q.—Do all marine reduction gears make use of a flexible connection between the driving pinion and the driven gear, such as the so-called "floating frame" of the Melville-McAlpine gear? M. C.

A.—No. The Parsons and De Laval systems adopt rigid connections, using fixed invariable bearings for both pinion and gear.

Weight of Aeroplane and Automobile Engines

Q.—Can you give me approximately the weight per brake horsepower of aeroplane and automobile engines? A. E.

A.—For engines complete, including flywheel, automobile engines range from 12-17 pounds per brake horsepower, and aeroplane engines range from 3-5 pounds per brake horsepower.

Temperature of an Air Pump Discharge

Q.—We carry customarily a vacuum of 26 inches. Will you please tell me the best temperature to have the air pump discharge? P. M.

A.—One hundred and ten degrees Fahrenheit is a good temperature. In general, from 10 degrees to 20 degrees below the temperature of saturated steam at the pressure of the vacuum is a good rule.

Size of Searchlight

Q.—About what size searchlight should I put on a 300-foot tramp freighter? What determines the selection of size? J. P. CALL.

A.—An 18-inch diameter unit would probably be satisfactory. There is no rule for determining a proper size, as it is a function of route and duty of the ship and her electrical equipment. In a ship of moderate dimensions there is usually ample power available for an 18-inch light and it is unwise to go much below this size.

Method for Finding Power of a Number

Q.—Will you please show me how to get the 2.83d power of a number? In the expression for net horsepower the speed comes in as $V^{2.83}$ and I am not sure that my method of obtaining it is correct. M. A. T.

A.—Let it be required to find $(14.27)^{2.83}$:

$$\text{Log } (14.27)^{2.83} = 2.83 \times \text{log of } 14.87 = 1.1723 \times 2.83 = 3.3176$$

(Number corresponding = 2078.)

It is easier to carry out the entire computation by logs, in which case

$$\text{Log log } (14.27)^{2.83} = \text{log } (2.83 \times \text{log } 14.87) = \text{log } 2.83 + \text{log log } 14.87 =$$

$$\text{Log } 14.87 = 1.1723$$

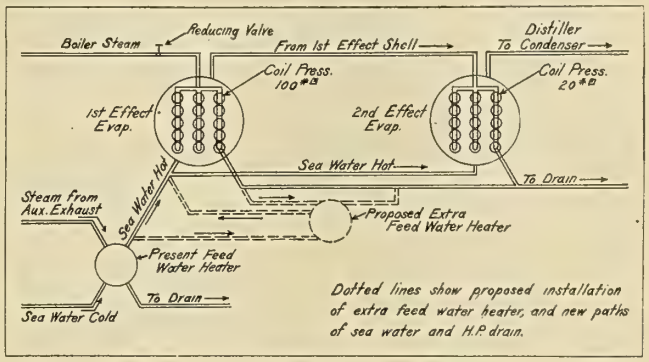
$$\text{Log log } 14.87 = 0.0690$$
$$\text{Log } 2.83 = .4518$$
$$\text{Log log } (14.27)^{2.83} = .5208$$
$$\text{Log } (14.27)^{2.83} = 3.3176$$
$$(14.27)^{2.83} = 2078$$

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Feed Heater for Evaporator Plant

Q.—We have two Reilly multicoil evaporators operated in series which have a total capacity of about 12,000 gallons per twenty-four hours. We operate usually on live steam at about 100 pounds gage in the first effect or high pressure coils and about 20 pounds gage in the second effect coils. The water fed to the evaporators passes through a feed water heater before entering and all the steam made by the evaporation passes direct to the distiller, where it is condensed into water. The feed heater operates on steam from the low pressure coils (about 20 pounds gage). It is proposed to increase the temperature of the sea water fed to the evaporators by installing an additional feed heater which is to derive its heat from the drains from the high pressure coils. Do you think this is feasible, and would you expect any gain in the amount of water produced, if it is put in? I inclose a diagrammatic sketch of the plant as it now is and as proposed. F. W. H.

A.—The scheme proposed will work well and should give an appreciable increase in capacity. It has actually been used and in one case when tests were made before and after the installation of this secondary feed heater in a plant very similar to that described a gain of about 23 percent in capacity was realized when the feed for both effects was sent through it. There is also undoubtedly



Arrangement of Evaporator Plant

some gain in efficiency, or pounds of water produced per pound of coal, as in the present condition you are returning water (the drain from the high pressure coils) at the very high temperature corresponding to 100 pounds pressure to the hot well with a considerable loss of heat on the way. The gain in *capacity* is not to be considered as an indication of a corresponding gain in *efficiency*, as the latter is much less.

Test of Steam Pump

Q.—I have on this ship two large reserve feed tanks and I plan to use one as a condenser and meter for a short test run on a steam pump that I have been altering. I plan to note the temperature rise after discharging the pump exhaust into the feed tank for about twenty minutes, multiply this by the pounds of water in the tank, and use this as the heat taken from the steam. If I know the heat per pound in the exhaust steam, which I can get from steam tables, I figure that the heat taken up by the tank, divided by the heat in one pound of the steam, will give me the number of pounds of steam condensed. Will you please tell me if my method is correct and suggest any points that need most careful attention? S. P.

A.—If the tank capacity is large and is accurately known, the method is approximately correct. You should, however, divide the product of the temperature rise and pounds of water by the heat contents of the exhaust steam *minus* the *heat contents* of the *condensate* (or heat of the liquid, which is nearly the final temperature in the tank, less 32 degrees) and *not* by the *total heat contents* of the exhaust steam. The quality of the steam at exhaust from the pump will have to be determined by a calorimeter and allowance should be made for the aug-

mentation of volume of the water in the reserve feed tank, due to the rise in temperature. (From 40 degrees F. to 140 degrees F. the increase in specific volume is 3/160 by Marks & Davis' Steam Tables.) The tank itself should, of course, be accurately calibrated and the vessel must be on an even keel and without list.

Electric Wiring

Q.—For electric lighting and general wiring on shipboard, is it necessary to run the wires in conduits? E. W.

A.—Conduits have been largely used for electric wiring aboard ship, but the most approved present practice is to dispense with them and use heavily rubber insulated leads not inclosed. When conduits are used there seems to be a tendency for moisture to accumulate in them, and the deterioration of the insulation is more rapid than when not inclosed.

Ahead and Backing Power of Engine

Q.—Can you tell me if the power of an engine is the same for the same boiler pressure and revolutions per minute when backing and when going ahead? I hold that it will be the same or even more, because the propeller is probably less efficient when backing. The chief says it is less and says that the backing crosshead guides are given less area for that very reason. It seems to me, though, that other things might have regulated that, such as length of time engine will be reversed, etc. A reply through your columns will be greatly appreciated. B. A.

A.—Considering the propeller alone, it has been found that for the same revolutions per minute and slip the power required to turn it reversed is roughly three-fourths of the power to turn it ahead. There are few full speed trials astern available for information as to power when the propeller is operating with the hull, but a recent trial of a high-powered twin screw vessel full speed astern gave an indicated horsepower of 84 percent of the go-ahead power at the same revolutions per minute. The cards were taken after the ship had gathered sternway and give reliable information. The power which a propeller requires varies with the slip, and with the ship under less sternway the same revolutions per minute might require somewhat greater power than above, but it would not be for a long interval of time. The backing guides of an engine are commonly made three-fourths of the area of the go-ahead guides for the above reason, and also as the time in reverse is rarely long.

New Books for Marine Engineers

THE NAVAL ARCHITECT'S, SHIPBUILDER'S AND MARINE ENGINEER'S POCKET-BOOK. Eleventh edition. By Clement Mackrow and Lloyd Woollard. Size, 4 by 6½ inches. Pages, 742. Illustrations, 264. London, 1916: Crosby Lockwood & Son. Price, 12/6 net.

This book, which has long been before naval architects and shipbuilders as a convenient reference book of formulæ, rules and tables, has been thoroughly revised and in many sections considerably extended to include recent data from modern practice in shipbuilding. Among the new sections inserted is one on speed and horsepower of ships which it is believed will be useful in enabling ships of ordinary form to be approximately powered from the data given. The necessity for economizing weight where possible without diminution of strength has led to the sections on strength of materials, riveted joints and stresses in ships being considerably extended. Information regarding British standard sections, screws, keys, etc., has also been added by permission of the Engineering Standards Committee. Finally, two new sections, one on aerodynamics and the other on aeronautics, have been added in view of the increasing importance of the recent development of aeronautics. The book is excellently arranged, but in common with the previous editions lacks the completeness that should be found in a naval architect's handbook.

MECHANICAL ENGINEERS' HANDBOOK. Edited by Prof. Lionel S. Marks. Size, 4⅝ by 7¼ inches. Pages, 1,836. Numerous illustrations. New York, 1916: McGraw-Hill Book Company. Price, $5.

This handbook, while based on the Hütte, represents the work of fifty eminent specialists in various branches of mechanical engineering and is intended to supply both the practicing engineer and the student with authoritative data covering the field of mechanical engineering in a comprehensive manner and in such form as to be immediately available for ready reference. While many of the sections of the book follow the Hütte closely, with the addition or substitution of American engineering data, nevertheless the greater part of the book, particularly those portions which deal with engineering practice, is new. In all there are fifteen separate sections in the book, listed as follows: Mathematical tables and weights and measures, mathematics, mechanics of solids and liquids, heat, strength of materials, materials of engineering, machine elements, power generation, hoisting and conveying, transportation, building construction and equipment, machine shop practice, pumps and compressors, electrical engineering, and finally engineering measurements, mechanical refrigeration, etc. A portion of the section on transportation is devoted to marine engineering, and this material is contributed by Dr. W. F. Durand, formerly advisory editor of this journal.

At the beginning of each section is a title page giving a table of contents for the section, while at the end of the book is a very complete alphabetical index comprising 56 pages covering the entire contents of the book. The book as a whole will be found a valuable aid to engineers, both on account of the authoritative data which it contains and the comprehensive and convenient manner in which it covers the field it is intended to serve.

Naval Architects' Annual Meeting

The twenty-fourth annual meeting of the Society of Naval Architects and Marine Engineers will be held on Thursday and Friday, November 16 and 17, at the Engineering Societies building, 29 West Thirty-ninth street, New York. The professional sessions will be followed by an annual banquet at the Waldorf-Astoria Hotel on Friday evening, November 17.

The following is a preliminary list of papers which have been promised for presentation at the meeting:

"Alquist Gearing for Ship Propulsion." By W. L. R. Emmet.

"Electric Cargo Pumps." By Hugo P. Frear.

"The Design of an Oil Engine." By John F. Wentworth.

"Aeronautics in Relation to Naval Architecture." By Naval Constructor H. C. Richardson, U. S. N.

"New Method Indicating the Density of Smoke as Installed on the U. S. S. *Conyngham*." By Rear Admiral R. T. Hall, U. S. N.

"Classification of Ships." By Norman E. McClelland.

"Maintaining a Navigable Channel by Revettment." By Parker H. Kemble.

"Dry Docks and Marine Railways." By Rear Admiral R. T. Harris, U. S. N.

"Dredging Equipment Used in the Panama Canal." By George B. Ward.

"Salvage Gear Used in Raising the *F*-4." By Naval Constructor J. A. Furer, U. S. N.

"Certain Tests of Ship Brakes." By John H. Hyde.

"Theory of Fluid Friction." By W. Gatewood.

"The Resistance of Various Types of Barges in Shallow and Deep Water." By Professor H. C. Sadler.

"Feathering Paddle Wheels." By Prof. E. M. Bragg.

"Model Basin Tests." By Naval Constructor Wm. McEntee, U. S. N.

"Shop Management." By Naval Constructor T. G. Roberts, U. S. N.

"Naval Stations and Naval Bases." By Captain A. P. Niblack, U. S. N.

"Power Process of Forging Heavy Chain Cable." By Naval Constructor F. G. Coburn, U. S. N.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Contracts for 20,000 tons of marine plate have been placed recently by shipbuilders on the Atlantic coast. In addition to this, 12,000 tons of steel ship plates have been sold for export, and negotiations are now being made for 10,000 to 15,000 tons more for domestic and foreign shipping. The principal buyers during the month were the Pennsylvania Shipbuilding Company, Gloucester, N. J., which is understood to have placed orders for 12,000 tons of marine plate for the construction of five vessels; The Standard Shipbuilding Company, which has placed orders for forgings for five vessels of from 5,000 to 8,000 tons deadweight capacity and for 8,000 to 10,000 tons of plate; and the Sun Shipbuilding Company, which has placed orders for 8,000 tons of plate for the construction of tank steamers for delivery in the first quarter of 1917. The export orders came from Italy and Japan.

Shipbuilding Contracts

It is reported from South Bethlehem, Pa., that the Bethlehem Steel Company, which recently acquired the Maryland Steel Company, Sparrows Point, Md., will make large additions to cost more than $30,000,000, and has placed an order to build five ore-carrying vessels of approximately 17,000 tons capacity each, to be built by the Maryland Steel Company. These vessels, so it is stated, will fly the American flag and will be operated by the Ore Steamship Corporation, a subsidiary of the Bethlehem Steel Company.

The Skinner & Eddy Corporation, Seattle, Wash., has received an order to build three more steamships for delivery during the last part of 1917.

J. Murray Watts, naval architect, Philadelphia, Pa., has designed two steamships for the United States & Ecuador Steamship Company, Philadelphia, Pa.; a four-masted barkentine for the American Tie & Timber Company, Savannah, Ga.; a 95-foot tug for the Poitevant & Fabre Lumber Company, Mandeville, La., and two steel motor barges for the Macon-Atlantic Transportation Company, Macon, Ga.

The Herreshof Manufacturing Company, Bristol, R. I., has received an order from J. P. Morgan, New York, to build a high-speed power yacht 100 feet over all.

The Oregon-Alaska Steamship Company, Portland, Ore., will, so it is stated, soon place an order for a freight and passenger vessel.

The John Wilson Shipyard, Seattle, Wash., has received a contract to build a motor freight boat, 80 feet long, from plans by F. A. Ballin, naval architect, Portland, Ore.

The Nova Scotia Steel & Coal Company, New Glasgow, N. S., will build a 300-foot freight steamship.

Rice Bros. Company, East Boothbay, Me., will build Light Vessel No. 99 at a cost of $61,000 for the Bureau of Lighthouses, Washington, D. C.

The China-American Motor Ship Company has been incorporated by Melbourne Crisp and L. McDonough, San Francisco, and L. A. Hewitt, of Oakland, Cal., to build five ships for service between Hong Kong and Vladivostock, with San Francisco as a home port. According to report these vessels will be of 2,000 gross tons, 256 feet long each, and will be equipped with oil engines.

The Pusey & Jones Company, Wilmington, Del., has received contracts to build eight more vessels for Norwegian interests, each about 300 feet long.

The Union Iron Works, San Francisco, Cal., has received contracts to build four steel shelter deck freight ships, each of which is to be 410 feet long. Two of these ships will be equipped with Curtis turbines.

The newly-organized American Shipbuilding Company, Astoria, Ore., a branch of the American Shipbuilding Company, of Cleveland, Ohio, has secured a contract to build a 315-foot wooden lumber schooner.

The Union Iron Works, San Francisco, Cal., has a contract from the Crowley Launch & Towboat Company, San Francisco, Cal., to build a 180-foot steel barge.

The Wallace Shipyards, Vancouver, B. C., have received a contract from H. W. Brown & Company, Montreal, Can., to build three wooden lumber schooners to be equipped with oil engines.

A London firm is reported to have placed an order for the construction of a steel steamer at North Vancouver, B. C. The steamer will be 315 feet long, 45 feet beam, with a carrying capacity of 5,000 tons and a speed of 9½ knots.

The Albina Engine & Machine Company, Portland, Ore., has taken a contract for repairs to the steamer *Kenyon Maru* amounting to about $235,000.

Robert Jacob, City Island, N. Y., was the lowest bidder for the United States coast guard cutter *No. 29*, which is to be 67 feet long and to have a speed of 18 miles per hour. Propulsion will be by two eight-cylinder gasoline engines, capable of developing 800 horsepower.

The Townsend Marine Railway & Construction Company, of Boothbay, Me., has received a contract from Crowell & Thurlow, of Boston, Mass., for a four-masted wooden schooner 200 feet long.

The Lehigh Valley Railroad has recently let contracts for a steel steam lighter with a capacity of 582 tons, one 23-car capacity steel car float and two 12-car capacity steel car floats, ten grain boats, each of 1,000 tons capacity, and six 90-foot covered barges for the transportation of general merchandise. This equipment is for the railroad's service in New York harbor, and is in addition to the orders placed a short time ago by the company for a tug, seven car floats, ten barges and an assortment of gasoline hoists, lighters and scows.

Shipyard News

The Elliott Bay Ship & Engine Company, Seattle, Wash., has purchased a 9-acre site on which a shipbuilding plant is to be erected. The president of the company, C. O. Morrow, states that he has already received sufficient orders to keep the plant busy for a year.

W. H. Curtis, Portland, Ore., writes MARINE ENGINEERING that he is starting a wooden shipbuilding plant and desires to get in touch with brokers or owners desiring vessels built.

The Delaware Shipbuilding & Engineering Corporation has been organized and has purchased a tract of 11 acres at New Castle, Del., where it will build a shipyard. At the beginning the company will confine its attention to the construction of wooden and steel vessels of the smaller type, running up to 300 feet in length. They will be similar to the ships used on inland waterways in Norway and Sweden. The plant will be in charge of an expert engineer from the lake district, who has also had extensive experience in Europe. As soon as possible arrangements will be made for constructing large vessels. The site has a frontage of 600 feet directly on the river and is considered an ideal place for a shipyard.

The North Pacific Shipbuilding Company has been incorporated and is planning to establish a shipbuilding plant at Portland, Ore., to operate in conjunction with the Smith & Watson Iron Works and the Northwestern Steel Works, of Portland, where the machinery for vessels built will be constructed.

It is reported from Portland, Ore., that a new shipbuilding company has been organized under the name of the Standifer-Clarkson Shipbuilding Company.

J. D. Barnes is president of the new company, which, it is reported, will build a shipbuilding plant in Alameda, Cal. It is also reported that this company has already received contracts to build two freight ships.

The Peninsular Shipbuilding Company has been organized at Portland, Ore., and will build wooden ships.

It is announced that the old Palmer shipyard at Noank, Conn., will be greatly enlarged and that the new owners will build six four-masted schooners. Captain Frank Meader is manager.

F. S. Pendleton states that he will build a ship repairing plant at Mystic, Conn.

The Samuel L. Moore Sons Corporation, Elizabeth, N. J., has had plans completed for carpenter shop, power house and office building, 50 by 75 feet, two stories, and 60 by 140 feet, one story. The architect and engineer, the Ring, Cleaves, Graham Company, 280 North Broad street, Elizabeth, is about to take bids.

D. E. Skinner, president of the Skinner & Eddy Corporation, Seattle, Wash., states that the company has sufficient work on hand to run at full capacity for more than two years. It has contracts to build ten ocean-going steamships to cost between $750,000 and $1,000,000 each.

The plant of the Great Lakes Engineering Works at St. Clair, Mich., has been bought by Pope Bros. & Cheppu Company, Ltd. It is reported that the property has been secured for the Canadian government, which, it is also reported, plans to take over the shipbuilding yards of the C. C. Smith Boat & Engine Works, Algonac, Mich., and the S. C. McLoud Shipbuilding plant at Marine City, Mich.

A contract has been let to J. A. Maceachern for driving piling for the ways of a new shipyard to be established near Astoria by the American Shipbuilding Company. The company is capitalized at $1,500,000, and it is reported that contracts for the construction of seven auxiliary schooners with a capacity of 2,250,000 feet of lumber have been secured from Hind, Rolph & Company, of San Francisco.

The plant of the California Shipbuilding Company at Long Beach, Cal., is now working with a full force of men that have taken every place vacated by the strikers. Open-shop conditions strictly prevail at the plant, and will continue to do so, according to the officials of the yards. The launching of two submarines now ready, with the exception of part of the machinery, was postponed until the last of August, because of the delay in the shipment of the machinery from the East. The laying of the keels of the new submarines to be built is also being held up on account of the failure of a shipment of steel to arrive on schedule time.

The Quebec Shipbuilding & Repair Company, Ltd., Montreal, has been incorporated, with a capital stock of $40,000, by Walter R. L. Shanks, Francis G. Bush, George R. Drennan and others to build ships, torpedo boats, etc.

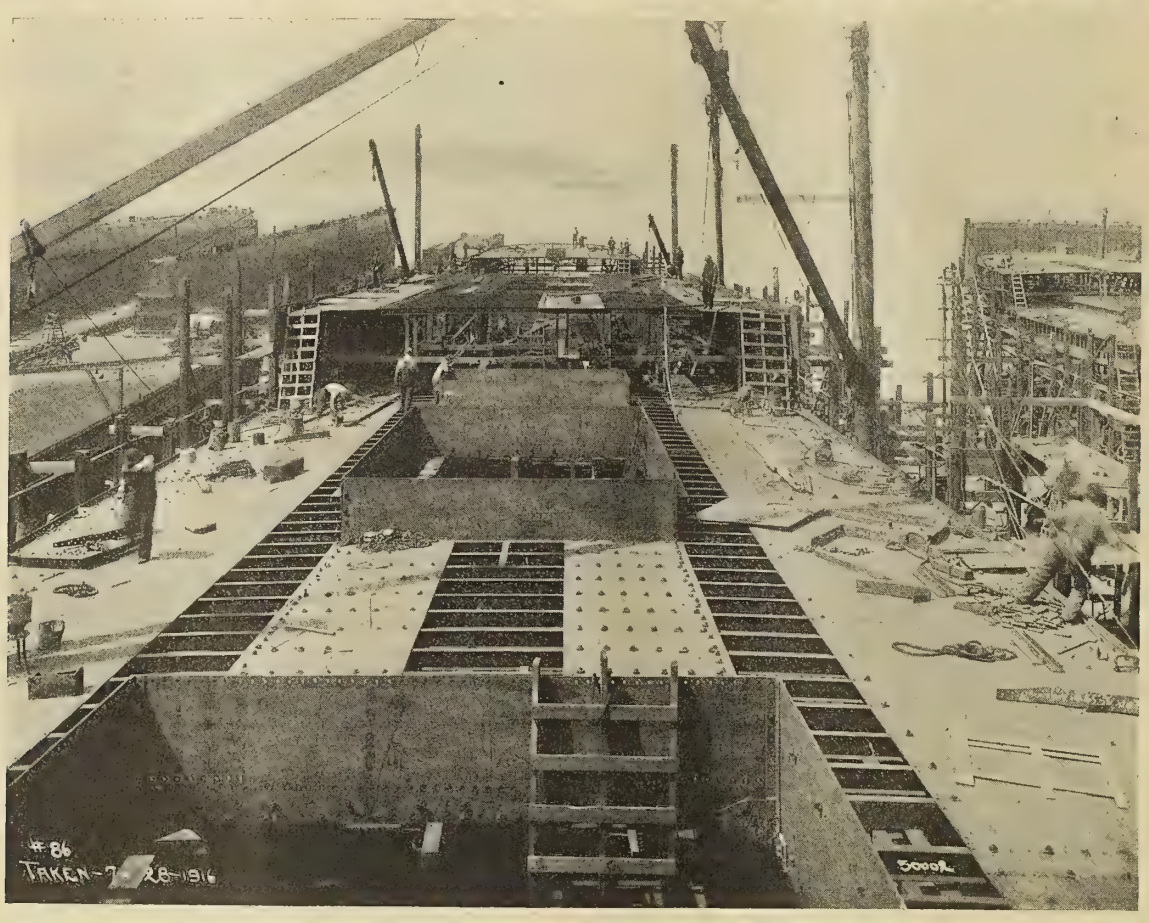
As showing the movement under way for expansion of the shipbuilding and drydock industries of the South, it is of interest to note that from New Orleans and Pensacola come announcements this week of new companies organized for undertakings in these lines. At New Orleans the Pan-American Shipbuilding & Salvage Company has been organized, with a capitalization of $1,000,000. The company proposes to install ways for four wooden ships, with complete facilities for repairing and constructing vessels. It will also equip a salvage outfit with seagoing tug, the company having acquired, according to reports, the exclusive rights in American waters for a simple and practical system of salvaging which reduces salvage costs one-quarter and the time to days instead of weeks and months, as in the old pontoon and lift systems.

On the Levis, or south shore, of the St. Lawrence, at the entrance of Quebec harbor, a new drydock, costing $3,000,000, has been under construction for more than a year.

The American Shipbuilding Company, Spokane, Wash., has already begun laying the foundation for its shipbuilding plant at Young's Bay on the Columbia River. It is planned to build at this yard five wooden schooners for the lumber trade before the end of the year.

Seattle Shipyard Under New Control

With the recent transfer of the controlling interest in the Seattle Construction & Dry Dock Company, Seattle, Wash., to the Todd Ship Yards Corporation of New York, J. V. Patterson, president of the Seattle concern for the past ten years, resigned, and his place has been filled by C. W. Wiley, marine superintendent of the Great Northern Steamship Company.



Progress of Work on July 28 on Ward Liner under Construction at the Yards of the Seattle Construction & Dry Dock Company

The new board of directors will consist of William H. Todd, of New York, president; C. W. Wiley, of Seattle, vice-president and general manager; H. W. Kent, of Seattle, secretary and treasurer; H. F. Alexander, W. H. Bogle, E. C. Ward and F. T. Merrit, of Seattle, and R. S. Walcott, of New York.

Mr. Alexander is president of the Pacific Alaska Navigation Company, W. H. Bogle and F. T. Merrit are attorneys, and E. C. Ward is vice-president of the Pacific Coast Steamship Company. C. W. Wiley is a graduate of the Massachusetts Institute of Technology and came to Seattle about sixteen years ago as marine superintendent of the Boston Steamship Company and Boston Towboat Company, which operated the Shawmut, Tremont, Hyades, Pliades and Lyra in the Seattle-Orient trade.

Plate Storage Area in Skinner & Eddy Shipyard, Seattle, Wash., Showing Yard Cranes

The Todd Shipbuilding Corporation also controls the Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y., and the Tietjen & Lang Dry Dock Company, Hoboken, N. J. Two new building slips are being constructed by the new concern and a 15,000-ton floating dry dock will be added to the three dry docks now in operation. Work on the new dry dock will begin at once. The yard has all of the new construction it can handle with its present capacity and all the repair work the shops can accommodate.

Progress of Work at the Skinner & Eddy Yard

The Skinner & Eddy Corporation, Seattle, Wash., has taken contracts for eight steel freighters and tank steamers and is figuring on two more. Two of these vessels are on the ways and the keel for the third will be laid in a few weeks. The driving of the piles of the ways for the third vessel has just been finished and the superstructure and planking are being added.

New shops are being built to take care of the additional work and everything is being done to handle the work as fast as possible. This yard is not a year old, but it is showing all of the energies and efficiency of an established concern.

The two steel freighters now on the ways are 423 feet 9 inches long overall, 410 feet between perpendiculars, 54 feet molded beam, 29 feet 9 inches molded depth, 24 feet loaded draft, 8,800 tons deadweight, and will have a sea speed of 10½ knots. They will be single screw of the poop, bridge and forecastle type, with the machinery amidships.

There will be two steel masts with four 5-ton and one 30-ton cargo boom on each mast, and two derrick posts each fitted with one 3-ton cargo boom. There will be four large and one small cargo hatch through the upper and second decks. Wide spaced hold pillars will be fitted, arranged so as not to interfere with the rapid stowage and discharging of cargo.

The propelling machinery will consist of one set of Curtis turbines, with reversing turbine in the same casing, connected to the propeller shaft by a two-stage reduction gear. There will be three Scotch marine boilers fitted with superheaters and arrangements will be made to use either coal or oil fuel.

The two tankers, the keel of one of which is soon to be laid, have been sold to the Standard Oil Company. They are to be built under the Isherwood patents and are 433 feet 6 inches long overall, 420 feet between perpendiculars, 57 feet beam molded, 31 feet 6 inches molded depth, 25 feet loaded draft, 9,500 tons deadweight, and will have a sea speed of 10½ knots.

The hold will be divided into tanks for carrying oil in bulk, and the machinery, which is the same as for the freighters described above, will be located aft. A double bottom will be built under the machinery space and used for reserve feed water.

A tank about 10 feet deep will be built in the fore hold for fuel oil, or water ballast. The fore and after peak tanks will be used for trimming tanks. The vessels will be constructed with a straight stem, elliptical stern and with two continuous decks. They will have a raised forecastle, short bridge house amidships and full poop aft.

Electric Propelling Machinery for the United States Battleship Tennessee

The contract for furnishing the necessary equipment for the electric propulsion of the U. S. S. *Tennessee,* now under construction, has been awarded to the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa. The system of propulsion being installed differs from any now in use by battleships. Two steam turbines, developing over 33,000 horsepower, will drive electric generators, which furnish current to four 6,700-horsepower motors, each motor driving a propeller.

In addition to the the main generating equipment and propelling motors, the contract includes the auxiliaries for the main turbine generator sets and smaller auxiliary turbine generators supplying light and power throughout the ship. The *Tennessee* will have several hundred electric motors for doing nearly all the work on board, from raising the anchor to steering. Electricity will also be used for cooking, ice making, refrigeration, and numerous other sundry purposes. In all about 37,500 horsepower of electricity will be needed, the amount required for a city of about 100,000 inhabitants.

A new shipyard has been established at Yokohama, capitalized at 3,750,000 yen, of which 937,500 yen has been paid up. The yard will be opened in November and orders for six vessels have already been secured.

A Vast Motor Ship Industry

Few shipowners are aware of the large number of our mercantile ships that are equipped with Werkspoor four-cycle type Diesel engines, and that only one other firm has a greater tonnage of ocean-going, oil-driven craft to their credit, and that particular concern's yard is entirely devoted to the construction of motor ships, whereas Werkspoor only have been able to devote part of their extensive works to this class of vessel.

They have been building stationary Diesel engines in large numbers for nearly seventeen years, and marine Diesel engines for nearly seven years. The following is a list of the ships (naval craft excluded) in actual service that are fitted with Werkspoor motors. The *Sebastian* was recently converted from two-cycle Diesel power of other make to Werkspoor four-cycle.

Name and Owners	Deadweight Capacity Tons	Indicated Horsepower Tons
San Antonio, A. Hammerstein	500	215
Cornelius, J. Van Rompu	600	265
Vulcanus, Anglo-Saxon Pet. Co.	1,900	500
Sembilan, Royal Packet Co.	300	265
Juno, Anglo-Saxon Pet. Co.	2,675	1,360
Emanuel Noble, Royal Shell Interests	6,500	2,750
Loudon, Royal Packet Co.	1,750	1,360
Artemis, Anglo-Saxon Pet. Co.	5,050	2,300
Ares, Anglo-Saxon Pet. Co.	5,050	2,300
Selene, Anglo-Saxon Pet. Co.	5,050	2,300
Hermes, Anglo-Saxon Pet. Co.	5,050	2,300
*Motrocine, Soc. Napthes Trans.	5,200	1,700
Elbruz, Royal Shell Interests	6,500	2,750
Jules Henry, A. Vimont	2,000	1,360
Poseidon, Anglo-Saxon Pet. Co.	800	450
Myer (Mijer), Royal Packet Co.	1,750	1,360
Siberg, Royal Packet Co.	1,750	1,360
Utrecht, Anglo-Saxon Pet. Co.	1,500	800
Lara, Anglo-Saxon Pet. Co.	875	650
Bengkalis, Royal Packet Co.	900	650
Boelongan, Royal Packet Co.	900	650
Sebastian, Lane & McAndrew	5,050	2,300
No. 17, Dutch Colonies Government	1,000	900
No. 22, Dutch Colonies Government	1,000	900
Totals	63,650	30,745

* The *Motrocine* was engined by a Werkspoor licensee.

It will be seen that altogether there are 24 Werkspoor Diesel engined ships in service, but many more are on order; in fact, their works at Amsterdam are overflowing with various orders. With auxiliary motors, the above engines must represent a turnover of over $2,000,000—this, of course, not including the ships and fittings—which will indicate how vast a business the marine oil engine is to this firm alone.

Recent Launchings

The schooner *James. M. W. Hall,* building at the Bowkers yard, Phippsburg, Me., for Rogers & Webb, of Boston, was launched on August 15.

The steam schooner *Stanwood,* 225 feet long, with a cargo capacity of 1,250,000 feet of lumber, was launched on July 15 at the Kruse & Bangs shipyard, North Bend, Coos Bay, Ore., for Bigsby & Clark, San Francisco, Cal.

The first launching at Aberdeen, Wash., in more than eight years took place on July 31, when the steamer *Oregon,* now building at the Peterson yard for Wilson Bros. & Company, of San Franciso, was launched. The vessel is 200 feet long, 48 feet beam, and 14 feet 8 inches depth, with a capacity for carrying 1,200,000 feet of lumber. The vessel was launched within five months after laying the keel, and is the first of two sister ships being built for the same company.

The Bath Iron Works, Bath, Me., launched on July 31 a 12-car capacity steel car float for the New York Central & Hudson River Railroad.

The steamer *Cormelia,* under construction for the A. H. Bull Steamship Company, New York, was launched at the Bethlehem Steel Company's yard at Sparrows Point, Md., on August 3. The vessel is 328 feet 6 inches long, 46 feet 6 inches beam and 25 feet 6 inches depth of hold, with a carrying capacity of 5,000 tons. She is the first vessel to be launched at this yard since the plant was taken over by the Bethlehem Steel Company.

The auxiliary tanker *Twilight,* building at Toledo, Ohio, for the Standard Oil Company of New Jersey, was launched on July 29.

The United States torpedo boat destroyer *Davis* was launched from the yard of the Bath Iron Works, Bath, Me., on August 15.

The first launching at the yard of the Chester Shipbuilding Company, Chester, Pa., took place on August 26. The vessel is an oil tanker of 8,000 tons deadweight, building for a Norwegian firm and will be known as the *Malmanga.* The length is 401 feet, the beam 54 feet and the depth 32 feet.

The steel barge *Dr. Brooks,* under construction for James J. McNally, was launched on August 10 at the yard of the Clinton Shipbuilding Company, Philadelphia. The new vessel is 195 feet long over all, 23 feet 10 inches beam and 15 feet depth of hold.

The new steel passenger and freight steamer *Henry R. Mallory,* of the Mallory Line, was launched on August 19 at the Newport News Shipbuilding & Dry Dock Company's plant, Newport News, Va. The vessel is being built for the New York-Texas trade, and is 439 feet in length, 54 feet beam and 34 feet depth. There will be accommodations for 100 first class and 100 second class passengers.

Marine Terminal Improvements

Snare & Triest Company, New York, were the lowest bidders for the construction of the pier shed at Fifty-fifth street and North River, New York. The amount of their bid was $337,751.

The Pennsylvania Lines West of Pittsburg are planning to extend docking facilities at Lorain, Ohio. Thomas Rodd, Pennsylvania Station, Pittsburg, Pa., is chief engineer.

The Baltimore & Ohio Rairoad Company, Baltimore, Md., F. L. Stuart, chief engineer, has appropriated $500,000 for improvements and additions to its docks at Lorain, Ohio.

The city of Muskegon, Mich., Paul Grimes, city engineer, is planning to build a pier.

The Standard Oil Company of New Jersey, Bayonne, N. J., has acquired a site adjoining Constable Hook, and plans to build wharves, bulkheads, etc.

The Lamport & Holt Steamship Company, New York, which operates a line of steamships from New York to Brazil and Argentina, has leased land in Hoboken, N. J., where it will construct two piers each 600 feet long.

The North Hudson Chamber of Commerce, George Limouze, secretary, 43 Columbia Terrace, Weehawken, N. J., is planning to build docks along the Hudson River.

The Port Commission, Astoria, Ore., is taking figures on a locomotive crane for the port docks.

The Minneapolis, St. Paul & Sault Ste. Marie Railway has awarded contracts for a reinforced concrete ore dock to be built at Ashland, Wis., which will have a total capacity of 60,000 tons. The structure will have a storage length of 900 feet, and will carry four tracks at an elevation of 80 feet above water level. Including a dock head of 75 feet the reinforced concrete portion of the structure will have a total length of 1,132 feet.

S. W. Bowen, chief engineer of the City Department of Public Utilities of St. Louis, Mo., in a recent report on a proposed terminal system for river traffic in St. Louis, estimates that to provide for present requirements, with a reasonable provision for future growth, four 300-foot docks would be required on Valentine street and the same number at North Market street. The estimated cost of these docks and warehouses, with their mechanical equipment, is $1,230,000. For extensions of the municipal railway system, about $554,000 would be required. Adding a reasonable percentage for contingencies, the total estimated cost of the whole municipal system would be $2,000,000 in round numbers.

The Chicago, Milwaukee & St. Paul Railway Company is extending its wharf system at Tacoma, Wash., by the erection of a new shed 175 feet in width by 1,000 feet in length; and the Oregon-Washington Railroad & Navigation Company has recently completed an improvement on the Middle waterway, by dredging, filling and the construction of the wharf and warehouse, to be occupied by fishing interests. In addition to these private improvements the Hylebos Creek Waterway Commission has recently let contracts for the dredging and dyking and reclamation work in connection with the improvements of the Hylebos Waterway, an undertaking similar in nature to the Duwamish Waterway project at Seattle.

Work was recently begun by the T. A. Scott Company, of New London, Conn., on the construction of a corrugated iron warehouse, 500 by 35 feet, on the State steamship pier in that port.

Baltimore's port facilities for the rapid handling of bulk cargoes and other heavy freight will be materially increased by the large, modernly equipped pier now rapidly being constructed at Canton, an industrial suburb of Baltimore, for the Clarence Cottman Company, Inc., an old-established firm of stevedores and steamship and forwarding agents. The pier will be 600 feet long on one side and 1,000 feet on the other, and on the shore end of this latter side will be erected a big sulphur storage warehouse having a capacity of 5,000 tons.

The pier will be provided with an electrically-operated unloading bridge, spanning four railroad tracks, and a high-speed box-car loader, these being especially designed for handling pyrites, sulphur and other ores, as well as all kinds of heavy freight, and later it is planned to add magnetic equipment for handling pipe, rails and other iron and steel products. Contracts were awarded to the Mead-Morrison Manufacturing Company, East Boston, Mass., and Chicago, Ill., for this equipment, which includes one unloading tower equipped with man trolley and operating a 9-ton grab bucket, and having a cantilever arm which extends over the hatches of steamers and enables the vessels to be unloaded at any point on the pier. A high-speed box-car loader, having a guaranteed capacity of 550 tons per hour, was also included in the equipment. The contract for the construction of the pier proper was awarded last May to the Sanford & Brooks Company at an approximate cost of $200,000. The construction is of reinforced concrete on timber piles, under the plans and supervision of the Cleveland Dock Engineering Company, of Cleveland, Ohio.

The Duluth, Missabe & Northern Railroad Company, Duluth, Minn., has announced that a new ore dock will be constructed on the site of Dock No. 2, and will cost approximately $2,500,000. The dock will have 384 pockets, each with a capacity of 350 tons of ore. All machinery on the dock will be operated by electricity. It is expected that the new dock will be completed at the opening of navigation in 1918.

The Pacific Coast Company has authorized the immediate construction of new terminals for the Pacific Coast Steamship Company at Juneau, to cost, exclusive of the ground site, about $80,000. The plant provides for a pier 480 feet long by 200 feet wide, with warehouses and fuel storage quarters covering about three-fourths of the floor space.

Shipbuilding Reports

A marked revival of the wooden shipbuilding industry is reported in Yarmouth, Nova Scotia. Twenty-nine sailing vessels, averaging about 250 tons each, have either been constructed during the present year or are in course of construction, which is about double the tonnage built in any recent year. Several new shipyards have been opened recently in Bigby County.

The monthly reports of the Bureau of Navigation show that 120 sailing, steam, gas and unrigged vessels of 28,682 gross tons were built in the United States and officially numbered during the month of July. Six of these vessels, of 16,567 gross tons, were steamships, the largest being the *William A. McDonagle,* of 7,811 gross tons, built by the Great Lakes Engineering Works at Ecorse, Mich.

The monthly report of the Imperial Japanese Department of Communications, as published on July 2, gives the number of seaworthy vessels in Japan as 2,146, with a total tonnage of 1,627,103. Of these 431 are ocean-going vessels of more than 1,000 tons each.

Outside of naval work, shipbuilding in Scotland decreased greatly in 1915, the greatest loss being on the Clyde. In 1914 the Scotch shipyards turned out 454 vessels of 508,945 gross tons and 540,290 horsepower, but in 1915 the total number of vessels built was only 207, of 233,501 gross tons and 205,288 horsepower. The total indicated horsepower of vessels built on the Clyde in 1915 shows a reduction relatively greater than the tonnage, the figures being 180,503, as compared with 496,120 in 1914.

According to figures compiled by the *Journal of Commerce,* from August 1, 1914, to August 1, 1916, a total of 1,486 merchant ships, aggregating 2,812,644 gross tons, were destroyed as the result of the war. Of the tonnage lost, 77.4 percent belonged to the Allied nations, 14.7 percent to the neutral powers and 7.9 percent to the Teutonic powers.

Lloyd's Quarterly Shipbuilding Returns

The returns compiled by *Lloyd's Register of Shipping,* which only take into account vessels of 100 tons and upwards, the construction of which has actually begun, show that there were 440 merchant vessels of 1,540,218 tons gross under construction in the United Kingdom at the close of the quarter ended June 30, 1916. The tonnage now under construction in the United Kingdom is about 117,000 tons more than that which was in hand at the end of last quarter, and about 33,000 tons more than the tonnage building 12 months ago. It will be understood that the rate of progress in merchant ship construction continues to be very much reduced in the present circumstances, and that the immediate output will be considerably less than that which would be obtained under normal conditions.

MARINE ARTICLES IN THE ENGINEERING PRESS

Equipment for Navy Yard Shops.—By Naval Constructor J. A. Furer, U. S. N. Paper describing arrangement of machines, method of drive and design and construction of concrete foundations for machinery. 6 illustrations. 13,000 words.—*United States Naval Institute Proceedings,* May-June.

The Passenger and Cargo Steamer Lesbian.—Description of single-screw vessel of 2,555 gross tons and 11 knots speed, driven by a triple expansion reciprocating engine and built by Messrs. W. Harkess & Sons, Ltd., at Middlesbrough, for the Elleman Lines, Ltd., for the Mediterranean trade. 2 illustrations. 1,800 words.—*The Shipbuilder,* June.

The Laws of Skin Friction.—By Charles H. Lees, D. Sc., F. R. S. Paper read before the Institution of Naval Architects, April 12, discussing the laws of skin friction of a fluid in stream line and in turbulent motion along a solid of great length. 6 illustrations. 3,800 words.—*Engineering,* June 2.

Reflections on the Great Sea Battle.—Editorial discussion of the lessons learned from the great naval battle between the British and German fleets off the coast of Jutland. 1,500 words.—*Engineering,* June 9.

The Effect of Bilge Keels.—By Prof. T. B. Abell. Paper read before the Institution of Naval Architects, April 12, describing experiments to determine the resistance of bilge keels to rolling. 6 illustrations. 3,000 words.—*Engineering,* June 9.

Oil Fuel.—By Ernest H. Peabody. Very complete paper discussing the production, refinement, distribution and use of oil fuel. Detailed description of apparatus and arrangements for burning fuel oil under steam boilers. 3 plates. 47 illustrations. 38,000 words.—*Transactions of the International Engineering Congress,* September, 1915.

Wave Proportions and Their Effects.—By Arthur R. Liddell. Discussion of the relations which the heights of waves bear to their length and their influence on the scantlings of vessels to resist bending moments due to wave action. 1,650 words.—*Engineering,* June 9.

Some Effects of the Bulkhead Committee's Report in Practice.—By A. T. Wall. Paper read before the Institution of Naval Architects on April 13, showing how the recommendations of the Bulkhead Committee will affect the design, construction and cost of several typical vessels. Approximate method outlined to facilitate the application of the new rules in design work. 20 illustrations. 3,400 words.—*Transactions of the Institution of Naval Architects,* 1916.

The Japanese Society of Naval Architects.—Brief account of the meeting of the Japanese Society of Naval Architects, held on October 23, 1915, with abstracts of papers on shipbuilding in docks, the breaking of propeller shafts, Japanese tonnage measurement, stress distribution in a plate, and longitudinal bulkheads and experience during the war. 5 illustrations. 2,000 words.—*Engineering,* March 10.

PERSONAL

A. H. Hanscom, formerly president of the Eastern Shipbuilding Company, New London, Conn., has been made general manager of the Robert Palmer & Son Shipbuilding & Marine Railway Company, of Noank, Conn.

Charles E. Hendrickson, for years chief accountant for Robert Wetherill & Company, Inc., Chester, Pa., has been appointed purchasing agent for the Sun Shipbuilding Company, of Chester.

OBITUARY

Ralph D. Williams, editor of the *Marine Review,* Cleveland, Ohio, from 1900 to 1915, died on August 14, aged forty-eight years.

J. K. Bythell, chairman of the Manchester Ship Canal Company, died at his home in Manchester on August 18.

George H. Carey, assistant treasurer of the William Cramp & Son's Ship & Engine Building Company, Philadelphia, Pa., died suddenly on July 22 at his home in Philadelphia, aged sixty-four years.

John Thomas Clark, formerly head of the Lehigh Coal & Navigation Company and of the Marine Department of the Lehigh Valley Railroad Company, died recently at his home in Port Richmond, Staten Island, aged fifty-nine.

John Albertson, a pioneer shipbuilder and founder of the Albertson Construction Company, died recently at his home in Greenpoint, Long Island, aged eighty-two.

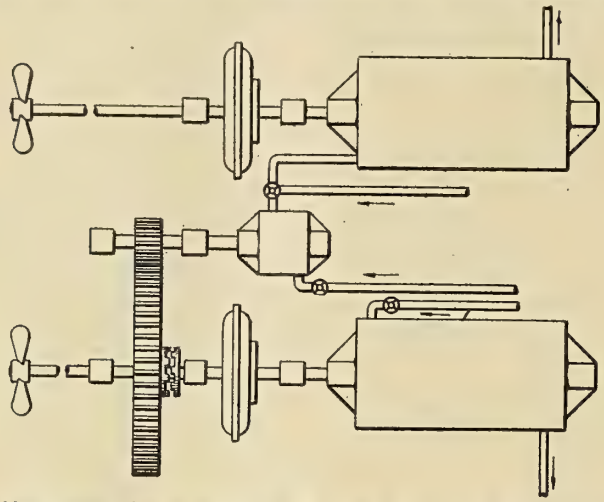
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,166,809. TURBINE POWER PLANT. HEINRICH ADAM BOHM, OF HAMBURG, GERMANY.

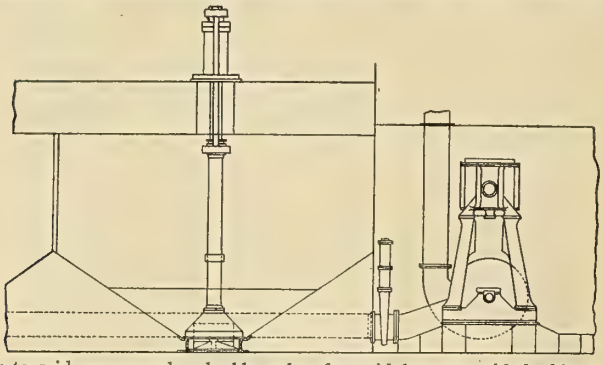
Claim 1.—A power plant including two driven members, two main turbines, two hydraulic power transmitters, each serving to transmit power from a turbine to its corresponding driven member, an auxiliary



turbine, means for transmitting the power from said last-mentioned turbine to one driven member and means for delivering the exhaust from said last-mentioned turbine to the main turbine of the other shaft. Fourteen claims.

1,187,250. HOPPER DREDGER AND BARGE. WILLIAM BROWN AND WALTER BROWN, OF RENFREW, SCOTLAND.

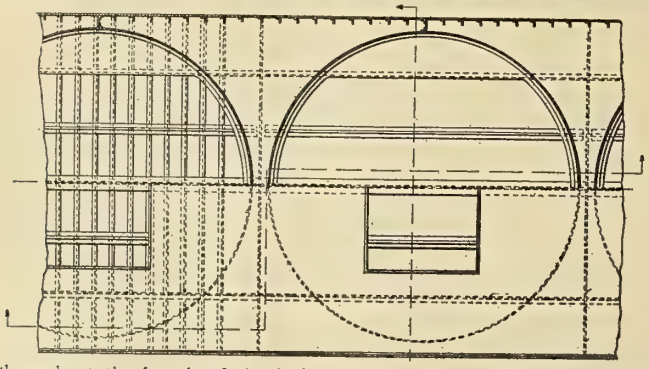
Claim 1.—In combination, a vessel provided with a hopper capable of being put in communication with the sea, a suction pump, a conduit lead-



ing to said pump, and a double valve for said hopper, said double valve comprising a member adapted to control communication between said hopper and said conduit, and a member adapted to control communication between said hopper and the sea. Two claims.

1,180,852. FLOATING VESSEL. CHARLES P. M. JACK, OF NEW YORK, N. Y.

Claim 1.—A tank vessel containing vertical walled tanks provided on each side with an upper longitudinal compartment and a lower longitudinal compartment the longitudinal walls of which are continuous

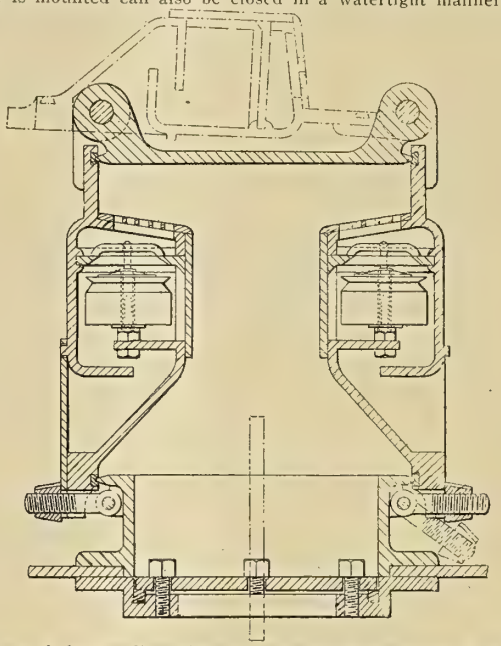


throughout the length of the body portion of the vessel, and connecting means between the compartments consisting of the side skin of the vessel and the portions of the tank side walls which lie between the compartments whereby the compartments are made to constitute upper and lower members of a girder for the longitudinal stiffening of the vessel. Two claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

7,666/15. VENTILATORS FOR SHIPS. T. UTLEY, OF SEFTON HOUSE, CROSSBY GREEN, WEST DERBY, LIVERPOOL, LANCASTER.

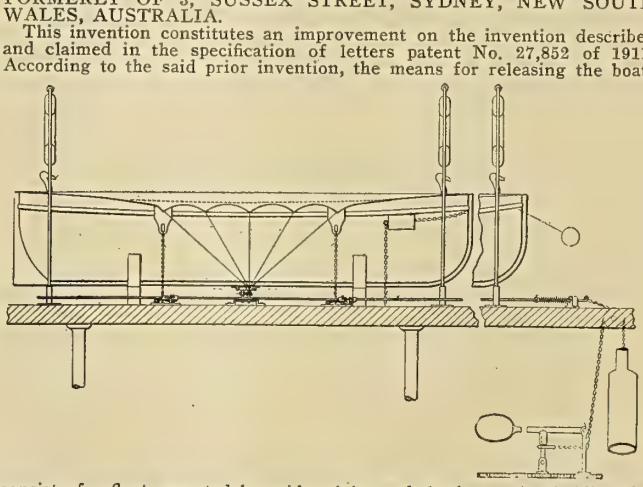
The chief object is to provide an improved construction of ventilator of the kind having valves to prevent ingress of water through the ventilation openings in rough seas. The improved ventilator is especially (although not exclusively) suitable for warships, in that it can be readily closed when the ship is going into action to protect the interior of the ventilator from the concussion of air due to firing of the guns; moreover, the ventilation aperture in the ship's deck above which the ventilator is mounted can also be closed in a watertight manner so that



in the event of the ventilator being destroyed or shot away by opposing gun fire there is no open passage through the aforesaid ventilation aperture in the ship's deck. According to this invention the main body or casing of the ventilator, which is adapted to be secured over the ventilation aperture in the ship's deck, is provided with one or more movable or hinged covers in which the air openings or ports leading to the interior of the ventilator are formed and in which valves are mounted so as to control the said air openings or ports to prevent ingress of water in rough seas, as aforesaid. In fine weather the covers are adapted to be readily moved into an open or inoperative position so that the air enters or leaves the ventilator through comparatively large apertures in the main body or casing without passing through the valve controlled openings or ports; the comparatively large apertures in the main body are adapted to be closed in a watertight manner by the covers in rough weather, for example. Baffles, or the like, may be provided in the air openings or ports in the covers to hinder any rush of water into the air openings or ports when the covers are closed. When the ship is going into action the valve-controlled openings or ports in the covers may be closed by suitable plates.

11,141/15. MEANS FOR SECURING SHIPS' BOATS INBOARD AND FOR RELEASING THEM AUTOMATICALLY OR AT WILL. T. OGILVY, OF 13 CRAIGHALL GARDENS, TRINITY, LEITH, FORMERLY OF 3, SUSSEX STREET, SYDNEY, NEW SOUTH WALES, AUSTRALIA.

This invention constitutes an improvement on the invention described and claimed in the specification of letters patent No. 27,852 of 1911. According to the said prior invention, the means for releasing the boats



consist of a float operated by said weight, and the boat gripe holding devices consist of a horizontal locking bar, and a pivoted cross bar adapted to engage with, and be withdrawn from an eye in, the locking bar. Now, various drawbacks arise from the use of a rope between the gripes of adjacent boats for the above-mentioned purpose, and in accordance with this invention the locking bars are connected with link mechanism and the operating means (i. e., float and weight mechanism), either through bell crank levers or directly, said link mechanism and operating means being common to a group of boats.